ANNUAL HIGHWAY ISSUE

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JANUARY 5, 1928

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Engineering News-Record

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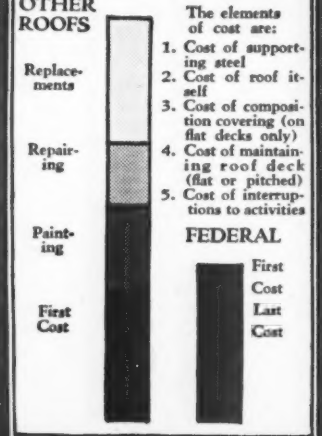

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Managing Editor

Volume 100 NEW YORK, JANUARY 5, 1928 Number 1

Engineering News-Record is a consolidation of *Engineering News* and *Engineering Record*, effected in 1917.

Engineering News was founded in 1874 by George H. Frost, as the *Engineer and Surveyor*, which title subsequently became the *Engineer, Architect and Surveyor*, then *Engineering News and American Railway Journal* and finally *Engineering News*, under the successive editorships of D. McN. Stauffer, Arthur M. Wellington and Charles Whiting Baker.

Engineering Record was established in 1877 by Henry C. Meyer as the *Plumber and Sanitary Engineer*. The name was subsequently changed to the *Sanitary Engineer, Engineering and Building Record* and, finally, to *Engineering Record*. During his ownership of the paper, Mr. Meyer was directly responsible for the editorial policy. John M. Goodell became editor in 1902, and was succeeded by E. J. Mehren.

The Contractor was consolidated with *Engineering News-Record* in 1918.

E. J. Mehren became editor of *Engineering News-Record* at the time of the consolidation in 1917, and was succeeded by the late Frank C. Wight in 1924.

The staff of *Engineering News-Record* consists of—

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A Road Issue

HIGHWAY construction and maintenance in the United States requires the expenditure of a billion and a quarter dollars every year. The business of directing this work and of manufacturing and purveying machines and materials with which to conduct it will be visualized and made articulate next week by the exhibition and convention at Cleveland, Ohio, of the American Road Builders Association. Annually for a quarter of a century these events have been growing in size and educational value. This year both the convention program and the number and size of the exhibits represent an advance beyond previous years. The "road show," as in the course of years it has come to be named, is the most complete portrayal of the mechanization of construction operations of a single class which can be found. It commands an audience of 30,000 people annually. In devoting to articles on roads the major part of this issue of *Engineering News-Record* recognition is given to an event and to activities which for the time being are of paramount interest to a large division of its readers. In the subjects selected for discussion—arterial roads, control of road concrete mixtures, development of local road material supplies, pavement repairs planned to reduce street closing time, highway marking and maintenance—the outstanding problems of the highway engineer are represented.

No Parking in Chicago

ACTION of the Chicago City Council in prohibiting parking in the loop district is a matter to command the attention of administrators and students of traffic control. One obvious advantage of such a restriction is that thus the entire street width, between curbs, is made available to moving vehicles. Few of us are there who have not been unduly detained by the natural result of parking—constriction of a traffic artery into a one-lane bottleneck. Relief from that condition can be hailed as a forward step in traffic control. Previously many other cities have forbidden or limited parking on individual groups of streets, but the new Chicago regulation is exceptional in its scope. Whether it will be in all respects advantageous remains to be proved by experience. Doubtless the inconvenience to individual automobile users is not wholly negligible. But the urgency of clearing the traffic lanes in central districts of cities today requires that opposing reasons be of overwhelming force to warrant consideration. The outcome of the Chicago experiment will bear interested watching.

Floods and Roads

HIGHWAY engineers in 1927, in New England and to a less degree in the lower Mississippi valley, have had to meet an unprecedented task in restoring highways damaged by floods. Speaking very generally, the roads of the flooded south, subjected to submergence only, have presented no very difficult restoration problem, either financially or physically. The experience was different in the torrential floods which devastated Vermont and to a lesser degree New Hampshire and the New England states south of them. Here, and particularly in Vermont and New Hampshire, roads and bridges were destroyed by miles and in hundreds. These two states have been confronted with a highway reconstruction task of first magnitude and they have attacked it with a promptness and energy which, it is confidently announced by both state highway departments, will make all main roads ready for the critical demands of the coming season's tourist travel. Perhaps legislative action in financing public service was never more prompt than when, in respective one-day sessions, Vermont and New Hampshire provided $8,000,000 and $3,000,000 of state funds in addition to regular appropriations, to reconstruct roads and bridges. In three weeks after the subsidence of the waters the major road reconstruction program of each state had been completely financed. In this three weeks the state highway departments had squared their organizations to the task and had started work with current funds.

Perhaps no single event has in recent years demonstrated more positively the effectiveness of our national and state set up for managing public roads. The national congress of a dozen years ago, which demanded definite state organization for highway improvement as a condition of participation in federal aid, accomplished as wise an act of public works legislation as records of lawmaking often disclose. Vermont and New Hampshire and all the flood striken states of the north and south have met the crisis of flood-damaged roads more efficiently because of federal partnership and influence for a dozen years.

Belated Laudation

NO HIGHER tribute to a municipal official could be wished than was given in the resolution of the city council of Chicago, lauding Dr. Herman N. Bundesen for his services as health officer of Chicago for the past six years. The laudation was late and in one important respect utterly futile. It should have been voiced to back up a refusal to approve the nomination by Mayor Thompson of his personal physician, with no standing as a public health administrator, to succeed a man who has done as much for Chicago as the resolution eloquently recites. The ousting of an able and faithful public servant is all the more unhappy and ill timed because Dr. Bundesen has but recently been honored with the presidency of the American Public Health Association and Chicago honored both by that and by the choice of the city for the next meeting place of the association. Indignation over Mayor Thompson's action led some members of the council of the association to propose that another city be chosen for the next convention. Happily that was not done. Now that the mayor of Chicago has followed an earlier New York example in putting the health of millions of people in charge of a man inexperienced in public health administration, the association just named, as well as other organizations in the civic field, should enter with new zeal upon a campaign of education to make such things less frequent in our cities, large and small. That may seem hopeless but it should be remembered that sometimes a little leaven works wonders.

Growing Pains

WITH the exception of Baltimore and New Orleans, which went without sewers until this century, it is doubtful whether any city ever carried through so extensive a sewer program in a single year as was done by Detroit in 1927. As stated on p. 959 of our issue of Dec. 15, some 325 miles of sewer, ranging from laterals to a trunk consisting of a triple box with each compartment nearly 16x18 ft. in size, were built, besides electric-driven pumping stations. By such extensive and costly work Detroit is trying to catch up with its recent great expansion of territory and population. In addition to lateral and trunk sewers, Detroit recently took steps to condemn land for building treatment works to care for the sewage of the entire city. All this is but a part of the construction work Detroit is carrying on to meet its rapid growth. A ten-mile tunnel forming a part of large extensions to its water-works system was described on p. 948 of our issue of Dec. 15. Street widenings, extensions of paving on large scale and other notable improvements are also under way. Such is the penalty and the pleasure of city growth. It is being experienced in greater or less degree throughout the country.

Arterial Road Problems

ARTERIAL highways are becoming an outstanding problem in public roads administration. Designed to give unimpeded passage to through travel across heavy-traffic metropolitan areas, and at the same time to maintain connection with main local-travel routes, they present a special problem in financing, engineering and operation. The article on the Holland Tunnel extension road from New York City through the metropolitan area of northern New Jersey, elsewhere in this issue, presents an exceptional yet typical example of the arterial highway. Few such roads will often call for a like combination of viaduct, subway and large bridge design and construction; none will escape major engineering problems of location and structure. Few perhaps will demand so high an expenditure per mile; all will be costly beyond comparison with ordinary trunk highways. Not many must have accommodations for 20,000,000 vehicles a year, but all must carry a fast traffic of many thousands daily. Like this road, all will be local special-service highways.

The problem which presses for solution is how to manage these enormous concentrations of road building funds and engineering and construction effort. New Jersey has financed its Holland Tunnel extension road, costing upward of $30,000,000, as a state-system highway from the regular funds available to the state highway department. It has designed and is constructing the road through a special division-engineering organization of the state highway department. Whether these are acceptable criteria for arterial road financing and construction everywhere, or at all, is a question which federal and state road administrations have immediately before them? It is not a question which can be regarded lightly. The local arterial super-highway is as much a demand of present day traffic as is a statewide surfaced road system and policies and plans for its development must be determined.

Snow Removal Progress

HALF of the state-system highway mileage of the United States will be kept clear of snow to permit all-time travel during the present winter. Specifically 117,000 miles of main roads in 36 states will be kept clear of snow at an estimated cost of over $5,000,000. These are the figures of the American Automobile Association which, until the states make their final after-winter accounting, is as reliable an authority as any. The association also estimates that for every hundred dollars spent in moving snow there is gained a thousand dollars in more efficient transportation and greater business continuity. Perhaps these estimates are as reliable as any figures of this very variable and uncertain value. The significant fact is that irrespective of financial gain, the motorist wants to travel in winter as freely as in the warmer seasons and will not countenance hindrances to his desire.

It is the experience of every state highway department that to satisfy travel snow removal must go far beyond the mileages on which a traffic can be found to justify the cost. Again it has to be remembered that the bulk of the investment in motor cars and the greatest portion of the annual travel of motor vehicles are in the snow-belt states. Specifically these states exhibit 70 per cent of the motor vehicle registration of the

United States. This means that an investment represented by over sixteen million motor vehicles is concerned in not losing road service for from one to four months a year because of obstructions by snow to motor vehicle travel. On such assumptions it is easy financially to justify almost any reasonable expenditures for snow removal. And really these expenditures are, in the light of total maintenance costs, not large. Last winter, 1926-27, they ranged from some $6 a mile in Virginia, the southern boundary of the snow belt, to about $136 a mile in Wyoming. The average cost for the whole 106,000 miles kept clear of snow was $43 a mile. So far at least our state highway department snow removal programs have not cost excessively compared with the lowest estimates of the value gained.

Reservoirs for Flood Control

UNDUE stress is being laid upon the value of power reservoirs in flood control as a result of what occurred in the Deerfield River valley during the recent flood in New England. The upper portion of the Deerfield River is highly developed for power purposes. Upon it have been built some large storage reservoirs for streamflow control purposes. It so happened that when the heavy rains which caused the flood came, one reservoir had been drawn down considerably to supplement the low flow of the river during the summer season and another was being drained for repair purposes. The combination of these two conditions gave the river such a large storage capacity that the flood wave was entirely absorbed in the two reservoirs and no flood occurred in the lower part of the valley. This fact is being heralded as indicative of the great advantage of power storage reservoirs in flood control.

Under certain conditions, such as the coming of unusual rains following a period of drought, power storage reservoirs are of value in reducing the flood flow. But the fact must not be lost sight of that, first, it was only chance which made so much storage space available in the Deerfield valley at the time of the heavy rain of early November, and, second, that had the reservoirs been full when the flood came—as is frequently the case with spring floods—their effect would have been negligible.

A power reservoir is not efficiently operated unless it is refilled at every opportunity. A flood-control reservoir, on the other hand, is not properly operated unless it is kept empty as much of the time as is possible. The only way in which the requirements of flood control and power supply can be met in the same reservoir is by a plan such as has been suggested in a number of cases of setting aside the upper part of storage reservoirs for flood-control purposes, increasing the height of dams for that purpose if possible in order not to reduce the storage available for power purposes, and forbidding the power company from ever holding back water above the level of the bottom of the flood-control section of the reservoir.

Where such an arrangement can be put into effect the storage made available could be used in reducing the intensity of *any* flood which might occur, but where no such plan is in effect storage reservoirs for power purposes never can be counted upon for flood protection with any certainty. They may, as was the case on the Deerfield River, be partly empty when the flood comes, but they may also be full to overflowing when it comes and be of no use whatsoever in checking its flow, except for the storage that is developed on the surface of the reservoir as the head over the crest of the spillway increases.

Flood control and power supply are not mutually exclusive but much harm can be done by giving the public the impression that any reservoirs built for one purpose will serve equally well for the other. At times it may, but again it may not, just when it is most needed.

Water-Cement Ratio Control

GREATER attention to the water-cement ratio, in designing concrete mixtures for road work, is urged by an article in this issue. While attentive reading is required there is little to be added to the clarity or to the force with which this article presents the main facts. Highway builders have been tardy in taking up a method of concrete mixture design which has proved valuable in other kinds of construction. Quick maturity of pavement strength is an economic gain to traffic. Greater ultimate strength and soundness are pavement structural assets. The question is not of these truths but of the practicability of the water-cement ratio specification as a field guide in concrete-mixture design for pavement construction. At present the answer is variously regarded as positive or negative by highway engineers and appears to be none too clear to any of them.

Chiefly, the trouble of the road builder has been with the fact that the water-cement relation, constant strength being the object, is not an invariable relation. It varies with the aggregates, with the curing conditions, with the temperature and with a number of other conditions. The practical road builder has seen therefore in water-cement ratio a series of relations each applying to one of the many sets of conditions arising in the field and has regarded it as too complex for practical application. It is in clarifying this doubt that the article in this issue is helpful. First, it makes it clear that ultimate precision in the water-cement relation, with highest strength as the sole objective, is not the criterion of a well designed road concrete mixture. Second, it points out that reasonably simple tests with the materials proposed for use will establish their relative economy and the water-ratio applicable to them. With this understanding water-cement ratio design of mixture becomes a not insurmountable complication in securing output in paving slab construction.

In carrying the process a step further to a definite quest for high-strength concrete, the article points toward an equally pertinent development—the recognition that traffic service is paramount in planning pavement construction. High early strength concrete calls for more than control of the water-ratio relation: there must be added cement; temperature regulation is important. Obviously these restrict high early strength mixtures to places where traffic needs are great. So far in practice these have been busy city streets, road intersections, approaches to railway station and similar situations where traffic may not be long interrupted, but the field is rapidly expanding to include main roads everywhere.

Obviously the problems and possibilities of the water-cement ratio principle in designing concrete mixtures for paving are only touched in these comments. The article itself is the important contribution and if it is read with attention to the lessons which it implies as well as to the facts which it expresse. it should encourage experiment with water-cement ratio control of concrete in road construction.

New Jersey Extension of Holland Tunnel Highway

Constructing a Highway, Without Grade Crossings, for 20,000,000 Vehicles Annually—Arterial Road Through New Jersey Metropolitan Area

By F. Lavis and S. Johannesson
Engineer and Assistant Engineer in Charge of Design and Construction, Jersey City, N. J.

THE metropolitan area of northern New Jersey presents a very special problem in the provision of highway facilities to meet the growing demands of vehicular traffic.

This area is a densely populated and highly developed industrial and residential district, some 20 miles in length and 10 miles in width, lying directly to the west of New York city and across all the main routes to the south and much of the west. The problem of providing highway facilities for the local needs of this district is in itself one of considerable magnitude, and requires continuous planning and large expenditures by the local municipalities and the counties. On this local traffic there is superimposed the tremendous volume of through traffic between New York and the communities in this district, the Atlantic shore resorts in the summer, and throughout the year, Trenton, Philadelphia, Baltimore, Washington and the south, and via Easton, to Pittsburgh and the west.

Arterial Highway Plan

By F. Lavis

THE State of New Jersey is undertaking to provide for through traffic across the metropolitan area, and as one feature of its program of relief is constructing a through arterial highway from the end of the Holland Tunnel on the west bank of the Hudson River, through Jersey City, Kearny, Newark and Elizabeth, to a connection with the existing state highway routes to the south and west of this last-named city.

The general location of this highway is shown by Fig. 1. It will be approximately 13 miles long and for some 7 miles at the east end—that is to say, for the whole distance through Jersey City, Kearny and the built-up section of Newark—will cross over or under all cross-streets, railways, etc., and permit its own traffic to pass freely and without obstructions. The total cost of the work as now planned will exceed $30,000,000.

The highway is designed solely for vehicular traffic and, for the first 9 miles, will have a roadway nominally 50 ft. wide, with no sidewalks. It is expected that with this width two lanes of traffic can be kept moving continuously in each direction, with one lane to spare. In times of a heavy flow in one direction there may be, of course, three lanes moving one way and one the other.

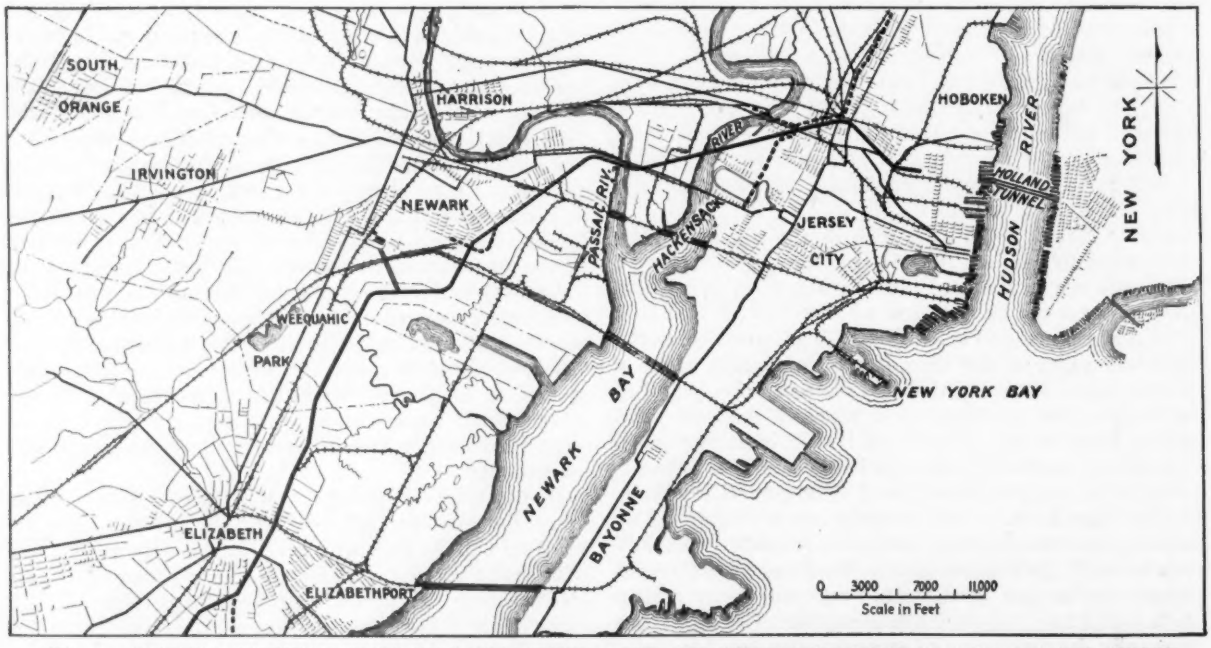


FIG. 1—ARTERIAL HIGHWAY FROM HOLLAND TUNNEL WEST THROUGH METROPOLITAN AREA OF NEW JERSEY
Heavy black line indicates tunnel extension highway; heavy dotted lines indicate tributary routes

The pavement is to be of granite blocks, with asphalt-filled joints, laid on a heavy concrete base.

While the main through traffic will pass over this highway without obstruction or interruption (saving accidents), provision will be made at intervals of about a mile, where important main routes are crossed, for traffic to enter or leave the main route by means of ramps, and always in the direction of the flow of traffic, with no traffic crossings.

It will be realized that the problems of location of such a route (necessarily, of course, on its own right-of-way) have been many, various and difficult. It is expected

that the road will carry a traffic of some 20,000,000 vehicles a year on the easterly section and possibly 12,000,000 to 15,000,000 on the westerly section, where there will be some grade intersections.

One of the important objects to be attained, therefore, is the passage of this traffic with as little interruption and difficulty as may be reasonably possible. This part of the problem is analogous in its general aspects to that of the location of a railway to carry a given volume of traffic. Curvature, rise and fall, distance, and delays, all have economic values in so far as they may affect the costs of operation of the vehicles using the highway. Studies of these values were made and used as an aid to judgment in comparing the various possible locations.

This route, however, while designed largely to take care of through traffic and thus relieve the congestion on the city streets and other highways of this part of the metropolitan area, must also provide for access to points of importance throughout the area, and this also has an important bearing on the location.

The question of the acquisition of right-of-way and the avoidance of undue expense for this purpose was also a question of extreme importance, it being obviously impracticable to attempt to cross and probably destroy large manufacturing plants, which are numerous throughout the district, while on the other hand such a highway, designed solely as a traffic artery, should if possible avoid important residential districts.

Fortunately it has been found possible to obtain very satisfactory alignment without unduly large expenditures for right-of-way.

On the easterly 8 miles the highway is built entirely on structures, of various types, the first section being a viaduct, Fig. 2, rising on a 3.5 per cent gradient from the lower part of Jersey City to Jersey City Heights, then passing under this part of the city as a depressed roadway, Figs. 3 and 4, thence across the meadows on a viaduct, with lift bridges over the Hackensack and Passaic rivers, to about mile 4, at the entrance to Newark. Passing along the lower side of Newark, the highway is built on an embankment with bridges over all cross-streets to about mile 5.5, then to mile 7 on a viaduct over various yards and tracks of the Lehigh Valley and Pennsylvania railroads to Haynes Ave., Newark.

From this latter point to the end, on the west side of Elizabeth, it is proposed at present to build the highway at grade, with a center roadway 50 ft. in width for the through traffic and a 20-ft. roadway and 10-ft. sidewalk on either side for local traffic.

The ramp connections to the Jersey City streets at the upper end of the viaduct are clearly shown in Fig. 2, the main roadway being shown in the center passing from the viaduct to the depressed roadway underneath these streets. The provisions for the interchange of traffic on the western side of Jersey City are shown in diagrammatic form in Fig. 5. At this point a second main route comes in from the north via Tonnele Ave. to the round-point on the surface of the ground, the main route passing on a viaduct overhead. Connection from the main route to the round-point is made by means of a center ramp. The secondary route then parallels the main route for some 2,500 ft., both passing over the Erie Railroad, the secondary route dropping to the surface of the ground at Charlotte Ave., there passing to the south under the main route with a branch leading to the Newark turnpike. Beyond this again another ramp leads up to the main route. It will be readily seen that any interchange of traffic between any of these secondary routes and the main route, or between either and the street system of Jersey City, can readily be accomplished without cross-traffic interference.

Part of the work in Jersey City has been completed and thrown open to traffic. Altogether some 5 miles are under construction or completed, the total amount of the contracts so far awarded being about $11,500,000. It is expected that the part of the route through Jersey City and that part which passes through Newark will be ready for traffic by the end of 1928, the rest of the work being pushed to completion as soon as possible thereafter.

The work is being carried out under the general direction of the New Jersey State Highway Commission, W. G. Sloan, state highway engineer; the design and construction of this highway are under the immediate direction of the writer.

FIG. 2—VIADUCT FROM TUNNEL PORTAL TO JERSEY CITY HEIGHTS

* * * *

Viaduct Design and Structure

By S. Johannesson

OF THE highway above described, some 25,000 ft. will be carried on viaducts. Of this, a length of 8,700 ft. has already been designed and 5,000 ft. has been built.

On account of the great lengths involved, and the costs of the structures, a thorough investigation was made, prior to final design, of the economy of the various types of viaduct structures which might be applicable for the purpose. In making this study certain basic conditions were fixed. The most important of these may be enumerated as follows:

1. The width of the roadway is nominally 50 ft.
2. No provision is made for pedestrian traffic.
3. Provision is made to prevent moving vehicles not under control from falling off the structures.
4. In the design of the structure, proper balance is made between the cost of construction and subsequent cost of maintenance.

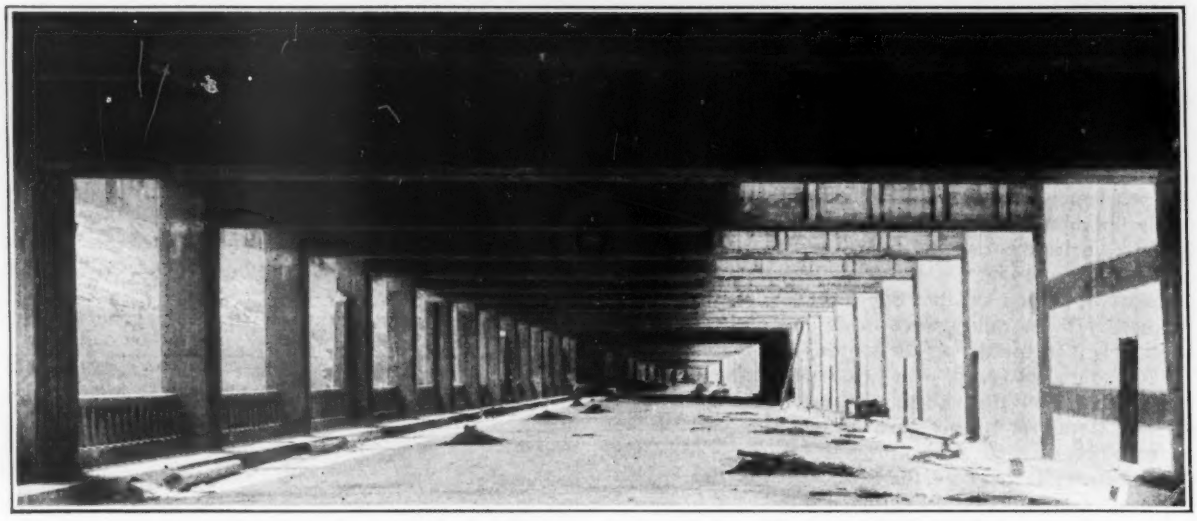


FIG. 3—VIEW OF DEPRESSED ROADWAY ACROSS JERSEY CITY HEIGHTS

The width of the roadway was finally fixed at 48 ft. 6 in. and footways about 2 ft. wide, with 8-in. curbs on each side. These footways provide safe passage for men engaged in maintaining and policing the highway, and the 8-in. curb furnishes a first barrier for stopping unmanageable cars. As a second and more positive barrier, it was decided to provide a heavy reinforced-concrete railing, supported on a continuous solid reinforced-concrete sill, 1 ft. above the sidewalk level.

As to the matter of proper balance between the cost of construction and the subsequent cost of maintenance, investigation indicated that, under the conditions governing this particular work, while the initial cost would be greater, it would be more economical, considering the cost of maintenance, to cover steel structures, if used, with a concrete or cement mortar protection than to paint them.

Based on these predetermined conditions, complete designs were made of a number of types of viaduct structures, both of concrete and of steel with a concrete or cement-mortar protection, with various span lengths. Comparative estimates of cost indicated that if the subsurface conditions were good, and the span lengths uniform, a reinforced-concrete structure with a moderate span length (say up to 40 ft.) would be the most economical. If, however, the subsurface conditions were such that greater span lengths were advisable, or if the surface conditions required longer or skew spans of varying lengths, a steel structure of simple supported girders or trusses was indicated as the more economical.

Actually, as the line of highway is laid on a new right-of-way, frequently crossing surface streets at all angles and railroads and railroad yards with tracks laid out in definite locations, it is only at certain places that it has been possible to use a reinforced-concrete structure. Usually, the surface conditions as found have necessitated steel structure.

A special study was made of the method of providing for the expansion of the viaduct structures. Sliding joints were not considered advisable for the concrete structures on account of the uncertain stresses that might be developed by a binding of the sliding contact. On the steel structures there was also an objection to sliding joints on account of the concrete or cement-mortar protection. It was decided, therefore, to use flexible twin columns at all expansion points, or, in other words, to support the adjacent spans here on separate column bents. In this manner the expansion changes develop elastic movements only. For the steel structures the required elastic deflection is generally readily obtained, but for the concrete structures it is sometimes a more difficult matter, on account of the larger cross-section of the concrete columns, to obtain sufficient flexibility of the columns. This is, of course, particularly true when the columns are short.

The twin columns of the steel structure are always joined at the base, and, when the columns are high, side

FIG. 4—VIEW OF ROADWAY OVER DEPRESSED ROADWAY SHOWN IN FIG. 3

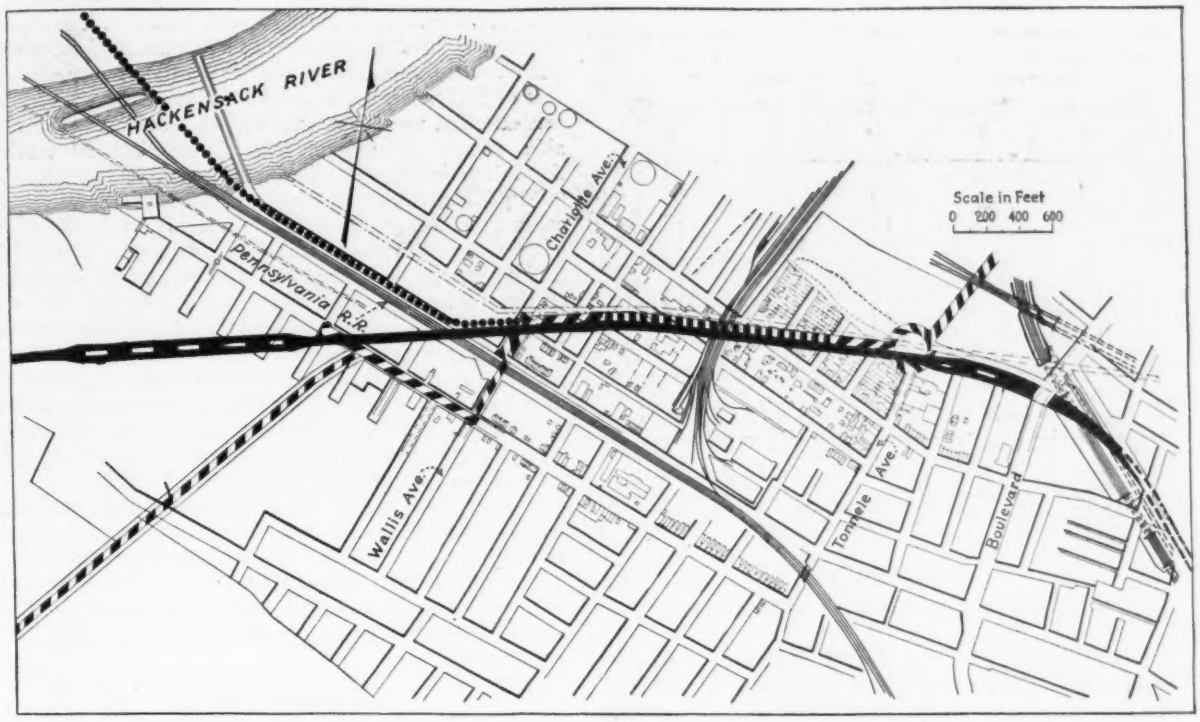


FIG. 5—ROUTE LOCATION FOR TRAFFIC EXCHANGE WEST JERSEY CITY HEIGHTS

plates are provided, joining the columns to such a height that the remaining free height is sufficient to provide the required elastic deflection. For the concrete columns all the available height is usually required. They are, therefore, set 2 or 3 ft. apart and the deck structure is cantilevered over the intervening space, thus gaining additional length of structure without additional supports.

In certain cases, where the viaduct structure consists of a single span supported on concrete abutments, it has, of course, not been possible to avoid sliding expansion joints. In order to prevent iron rust stains on the concrete at such places, the metal parts which could not be covered with a concrete protection have been made of bronze.

The expansion joint in the roadway surface is formed between two vertical, transverse steel plates, the space between which is filled with asphalt mastic. A description of this joint was given in *Engineering News-Record*, April 7, 1927, p. 564.

All viaducts are designed to provide a minimum clearance of 14 ft. over public streets and 22 ft. over railroad tracks, and to carry on one span length a live load of two 20-ton trucks per traffic lane plus a uniform load of 80 lb. per sq.ft. on the area not covered by the trucks.

The deck is a concrete slab covered with waterproofing of the membrane type. Immediately on top of the waterproofing membrane is a protective layer of 2 in. of cement mortar, on which the roadway pavement is laid. The pavement consists of granite blocks on a sand cushion, the joints between the blocks being filled with asphalt mastic. Where the grade of the roadway is heavy (the maximum gradient used is 3½ per cent) a cement-mortar cushion is used instead of the sand cushion to prevent possible sliding of the cushion and pavement. The sidewalks are of concrete and the curbs are protected with heavy steel angles. The standard over-all width of the viaduct is 55 ft. 6 in.

Where connections are made between the highway on the viaduct and the surface streets, the highway is usually divided into two separate roadways, one for eastbound and one for westbound traffic, and a ramp connection to the surface streets is made between these two roadways. In a special case, however, where the local conditions did not permit this arrangement, the highway proper was carried through in the center and the structure was widened on both sides so as to provide room for two ramps connecting to the surface streets, one for eastbound and one for westbound traffic. A view of this structure, which has an over-all width of 120 ft. at the widest point, is shown in Fig. 2.

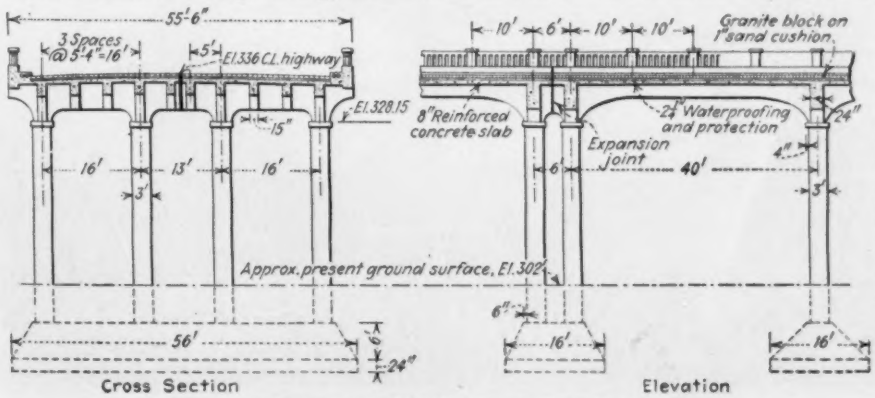


FIG. 6—GENERAL DETAILS OF CONCRETE VIADUCT

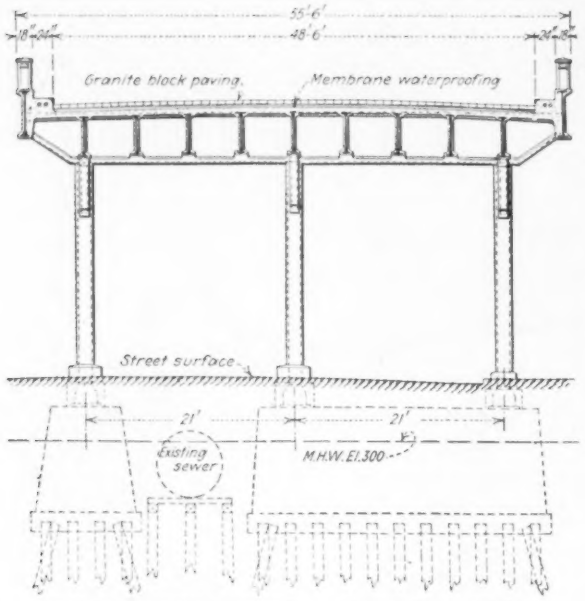


FIG. 7—GENERAL DETAILS OF STEEL VIADUCT

The foundations for the viaduct structure are of concrete. Usually the subsurface conditions have been such that the foundations could be built directly on the ground when excavated to a reasonable depth. In certain cases, however, particularly in the easterly part of Jersey City, where the land is low and where the upper strata are mud and soft clay, it was necessary to extend the foundations to considerable depths. In most of these cases pile foundations were used. In addition to the vertical bearing piles, batter piles were driven to provide lateral support. Near the easterly slope of the Palisades, which rise abruptly above the lowlands, the borings indicated that the soft clay extended practically to the rock, which at this point is approximately 60 ft. below the surface. As the surface conditions necessitated long spans at this point, it was deemed advisable to use caissons. These caissons are of concrete, circular in shape, from 8 ft. to 10½ ft. in diameter, and were sunk to rock by means of compressed air.

Fig. 6 shows general details of the standard concrete viaduct structure. Longitudinally it is designed in monolithic units of four span-lengths. Transversely the structure is shown to consist of a slab supported on longitudinal girders, framed into the cross-girders, which are supported on the column bents. Each column bent has four columns. In order to avoid undue indeterminate stresses, a joint has been made longitudinally through slab and cross-girders so that the structure consists in fact of two separate but parallel units. To avoid uneven settlement of these two units and to provide more favorable stress distribution, the foundation is carried through solidly under all four columns.

Fig. 7 shows general details of the steel structure. It consists of a concrete slab, carried on longitudinal girders, spaced about 5 ft. center to center. The longitudinal girders are framed into cross-girders supported on three columns. This is the standard design, but local conditions frequently have required deviations from it. Where long spans are required, for example, the design has been modified to consist of three longitudinal girders or trusses, each preferably carried directly on one of the three columns of the transverse bent. Secondary cross-girders are carried by these longitudinal girders and, in turn support stringers at the standard spacing.

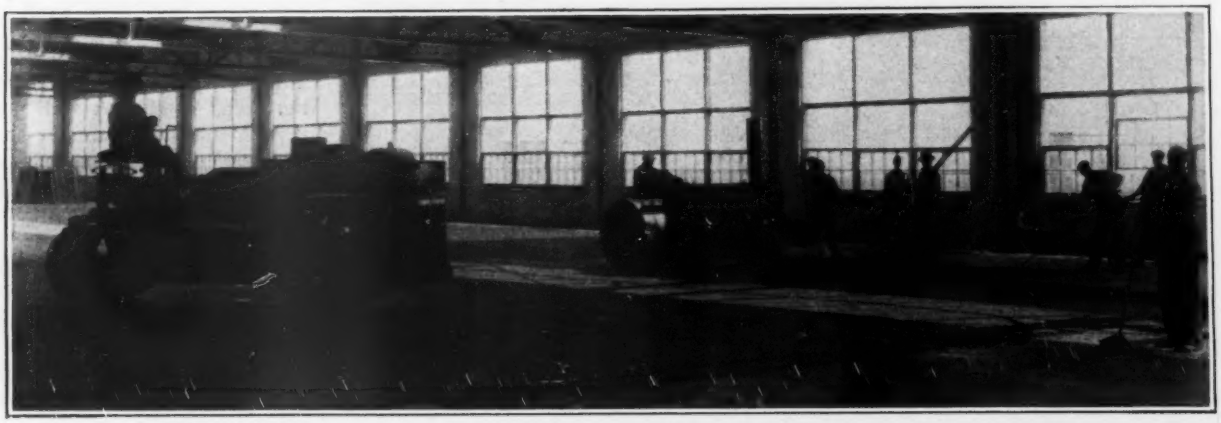
In other cases, where the construction height has been limited, it has been necessary to use through bridge construction or other means to carry through the viaduct structure. In fact, the local conditions have been such that nearly every span length of the viaduct has presented new conditions requiring special treatment to meet their requirements.

Asphalt Floor Laid and Rolled Like Street Paving

Especially Designed Mixture With Special Filler Laid 1½ In. Thick on Concrete Floors of Factory Building

By Hugh Skidmore and Jerry Donohue
Respectively, Chicago Paving Laboratory, Chicago, and J. Donohue Engineering Company, Sheboygan, Wis.

WHEN plans were drawn for the large shipping building for the Kohler Company, at Kohler, Wis., the question of floor surfacing arose. Throughout most of the plant the concrete floors had proved unsatisfactory under heavy steel-shod truck traffic. In a shipping building, particularly in a warehouse, the matter of resilient shock-absorbing floors should receive every consideration. It was first planned to cover the six floors, comprising 174,000 sq.ft., with asphalt mastic, and bids were taken on this type. Contracts were let about the same time for sheet asphalt surfacing in the village. The



CREW AND EQUIPMENT LAYING SHEET ASPHALT FLOOR WITH STREET PAVING OUTFIT

thought came to the engineer consultant (Mr. Donohue) that possibly this type of surfacing might be utilized to advantage on the floors of the new building.

The question was submitted to the laboratory in charge of the asphalt street-paving construction in the village. It was answered in the affirmative, provided the concrete floors would sustain the weight of power rollers and the spacing of the columns would permit the operation of the rollers. These two points having been satisfactorily disposed of, the contractors for the village paving, J. Rasmussen & Sons, of Oshkosh, Wis., were asked to submit a price for the work, to consist of 174,000 sq.ft. of special sheet asphalt 1.5 in. thick. The bid submitted by them showed a saving of about $11,000 over the best price quoted for 1.25-in. mastic.

Before drawing specifications a laboratory investigation was made with sheet asphalt mixtures employing various fillers and regular paving asphalt of low penetration. It was obvious that extreme temperatures would not be encountered, hence comparatively hard asphalt could safely be used; but traffic of a most severe character must be provided for by means of an unusually stable mixture. Materials used in the laboratory investigations were:

1. Asphalt cement (Mexican) of 26 penetration at 77 deg. F. and 1.059 specific gravity.
2. Sand (available locally):

Specific gravity	2.63
Per cent voids	31.8
Per cent passing 80-mesh	34.0
Per cent passing 40-mesh	48.0
Per cent passing 10-mesh	18.0

3. Fillers:

Kind	Specific Gravity	Per Cent Passing 200-Mesh
Limestone dust	2.710	83.0
Hydrated lime	2.328	100.0
Celite	2.160	95.0

High percentages of hydrated lime capable of producing desirable shear strength proved very difficult to handle and although this material showed higher shear value than equivalent amounts of limestone dust, it was necessary to abandon its use on account of lack of workability of the mixture. Limestone dust gave the usual excellent results, but when it was found that substituting Celite for one-fourth of the total filler content in a 20 per cent filler mixture (15 per cent limestone dust and 5 per cent Celite) gave shear strength 2.5 times as great as 25 per cent of limestone dust alone, this combination was selected as the one for the job.

Work laying the first floor began June 20 and proceeded upward floor by floor to the fifth, then to the basement, which had to be laid last, as the concrete subfloor had not been laid when the work was started. The work was completed July 15; thus an average daily production of 965 sq.yd., or 8,685 sq.ft., was accomplished The window sash was not in place on the lower floors at the time, and this made the work more difficult on account of the strong, chilling drafts and rains. Both production and smoothness of finished work increased when the upper floors were reached, due to the absence of sweeping air currents across the building.

The manufacture and laying of the mixture followed the same procedure that was in use on street-paving operations—in fact, the same organization and equipment completed the sheet asphalt work in the village one afternoon and began the flooring work the following morning, the only exception being the rollers used. On account of the impossibility of getting heavy rollers of 10 to 12 tons weight into the building and of moving them from floor to floor (they were too large to enter the elevator shafts), two smaller rollers were employed. These were a 2.5-ton, three-wheeled roller and a 4-ton tandem, which were lifted from floor to floor by block and tackle through the elevator shafts. Experience on the work quickly demonstrated that the small three-wheeled roller was ideal for this type of work and was preferable to the tandem, which, although heavier, did not compress the mixture so well. Numerous samples from finished work conclusively demonstrated that the mixture was being compressed to practically maximum density. This spoke well for the workmanship, the design of the mixture and the accuracy of control.

All materials were weighed directly into the mix except Celite, which was measured by volume and discharged directly into the batch of mineral, all of which was given a thorough mixing before the hot asphalt was introduced. The plant was only a few hundred feet from the building and ample mixing time was possible without curtailing production. The specifications called for a 1½-min. mixing period, which is 50 per cent more time than the minimum specified for ordinary asphalt paving mixtures. This precaution was taken to insure thorough distribution of the light and more or less flocculent Celite. The mixture was discharged at a temperature of 400 to 415 deg. F., this being somewhat above prevailing mixing temperature but was advisable to insure proper temperature for spreading and compressing, due to low penetration of the asphalt and prevailing cool weather at the time.

The hot mixture was delivered in Ford trucks having dump bodies. The trucks were in turn transported from floor to floor in the freight elevators. The laying operations followed the well-known practice, including luting of the freshly raked material just before initial rolling. The mixture was very workable at proper temperature but naturally stiffened rather quickly if the raking were delayed. The presence of the very finely divided spicules of diatomaceous silica seemed to render the mixture more than ordinarily responsive to compression by rolling. Surface honeycombing was never in evidence unless the initial rolling operation was delayed too long.

Emergency Ventilator in Chlorinating Room

Apparatus for feeding chlorine gas into the city water at Albany, N. Y., is located temporarily in a room underneath the sidewalk adjoining the main pumping station. As pumping station attendants do not maintain or operate this apparatus, it is necessary to notify the man in charge whenever leaks occur in the gas line. To prevent the gas from escaping into the pumping station, there is an air-tight door to the chlorinating room. A small electrically-driven blower draws air from near the floor of the chlorinating room and discharges into the outside atmosphere. This blower is started from a switch located in the pumping station just to one side of the doorway to the chlorinating room. When a leak occurs in the chlorine gas piping system, the pumping station attendant merely closes the door and starts the blower, which is kept running until the man in charge of the chlorinating apparatus arrives and makes the necessary repairs. The arrangement is temporary, continuing only until a new pipe line can be constructed to replace the existing pipe line from the filtration plant to the pumping station. This apparatus adds a second dose of chlorine to the water, the first dose being applied at the filtration plant, 1½ miles from the pumping station.

Ohio Road-Sign Paint Shop Plant and Methods

Factory Operated by State Highway Department Equipped to Produce Over 1,000 Signs a Day—Wood Shop-Paint Mills—Spraying Booths—Stenciling Tables—Drying Racks

By Harry E. Neal
Traffic Engineer, Ohio Department of Highways,
Columbus, Ohio

PRIMARILY to place the marking of the Ohio state highway system on a more efficient basis, a separate Traffic Bureau was created in 1921. In addition to the marking, this bureau was placed in charge of all traffic matters coming within the jurisdiction of the department. The first step in organizing the work of marking was the appointment of a route marking superintendent in each of the eleven highway department divisions of the state to take charge of the field work under definite instructions from the central office.

FIG. 1—SILK SCREEN STENCIL JUST LIFTED FROM STENCILED SIGN

At the time the field work was placed under the route marking superintendents all signs were being made at the state penitentiary. With active field work the penitentiary was unable to turn out signs fast enough to meet the demand. To supplement the supply orders were placed with private concerns. This proved unsatisfactory; there were exasperating delays in deliveries and poor materials and workmanship.

Having the signs painted by the division forces was tried. Boards and paper stencils for the various designs were supplied by the central office. This resulted in eliminating most of the delays but the results were very unsatisfactory. Inexperienced labor was employed and the signs were crude. The cost also was excessive. It was finally determined that the solution of the problem of producing signs of the maximum quality at the minimum cost and at the required speed was to establish a central plant under direct control of the Traffic Bureau. The views and description which follow show the final development to date of this plant.

Silk Screen Stenciling Process—The sign shop manufactures wood signs by the silk-screen method. A silk screen stencil consists of a diaphragm of silk bolting cloth stretched tightly upon a wooden frame, Fig. 1. The lettering or design is blocked out on the silk with a lacquer or "filler" which is not affected by the oil paints used in stenciling. The grade of silk found most suitable is known as 10 xx, with 109 meshes per lineal inch.

The screen frame is $1\frac{1}{4}$x$2\frac{1}{4}$ in. white pine. Its inside dimensions exceed the dimensions of the signs to be made by about $1\frac{1}{2}$ in. in width and 8 in. in length. One end member and two side members have $\frac{1}{2}$x$\frac{7}{16}$-in. grooves into which oak strips fit snugly. Across the other end of the frame, and inside it, is an adjustable cross member in which is a groove with an oak strip to fit. This cross member is supported by two $\frac{3}{8}$x7-in. carriage bolts with wing nuts passing through the rigid end member.

In making a stencil the silk is tacked to the three grooved members of the frame and to the adjustable end member, being stretched tightly and evenly by hand across the grooves. The oak strips are then forced into the grooves, further tightening the silk. The strips are held in place by screws. The silk is finally drawn as taut as possible by tightening the wing nuts to draw up the adjustable end member.

The design is penciled on the silk by tracing from a drawing and is blocked out with the filler which dries rapidly; the screen is ready for use in five or six hours. The lacquer paint or filler may be purchased ready for use or a very satisfactory filler may be made according to the following formula: $\frac{1}{8}$ lb. English drop black dry; 1 qt. orange shellac; 1 tablespoon castor oil. This filler may be thinned as desired by adding a solution of 5 parts alcohol and 1 part castor oil.

A special table, Fig. 2, is provided for the stenciling. This table is $3\frac{1}{2}$x7 ft., is about 30 in. high, and is provided with casters. In the top of the table are four metal plates with slots which serve as guides for two movable stops made of 1x1x$\frac{1}{8}$-in. angles 18 in. in length. These stops may be moved back and forth independently but remain at right angles to each other. Two blocks of the

FIG. 2—STENCILING TABLE FOR SILK SCREEN WORK

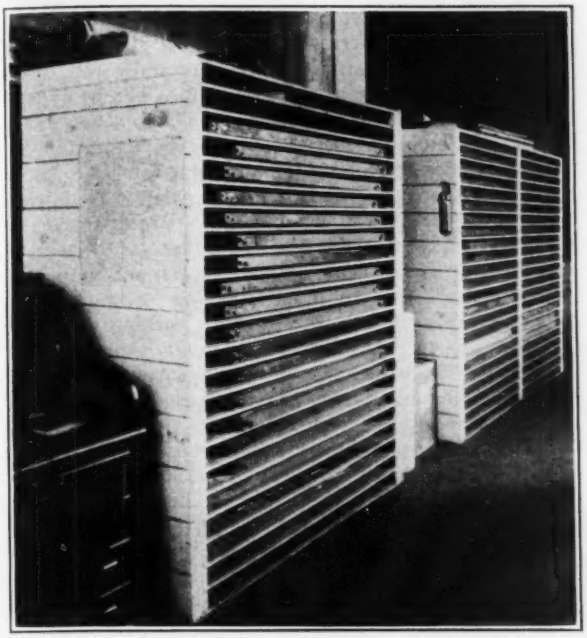


FIG. 3—FILING CASES FOR SILK SCREENS NOT IN USE

thickness of the sign to be stenciled are attached to the top of the table. Each of these blocks has attached to it one half of a loose-pin butt hinge. All screen frames have two halves of corresponding hinges so spaced as to fit the halves on these blocks. The table has an upright at each end supporting a horizontal cross member carrying small pulleys over which passes a clothes-line rope with a counterweight.

In preparing to use the silk screen stencil, the frame is hinged to the blocks on the table and is lowered over a board of the size to be stenciled. The board is adjusted until the design on the screen registers properly. The movable stops are then brought up to the edges of the board and clamped in place. This insures mechanical registration of the design on all signs to be stenciled by this screen. The free end of the rope is attached to the free end of the screen to hold the screen free from the table when placing and removing boards.

In operation the screen is lowered onto the board and a small quantity of semi-paste paint is placed at one end. The paint is forced through the open mesh of the design by drawing it across the screen with a rubber squeegee. This transfers the design to the board. The screen is then lifted, the finished sign removed and another board inserted. It has been found that it is more economical to use two men to operate the screen—one to place and remove the boards and the other to do the stenciling.

The stenciling process is very rapid. In actual work two men have stenciled 1,100 boards 24x24-in. in 8 hours. At this rate the cost of stenciling is less than 1c. per sign. Of course this rate of production is rarely required but it serves to indicate the speed and low cost possible.

The silk screens will last indefinitely if properly cared for. The principal requirement is that the paint shall be thoroughly cleaned off before it dries. This is easily done by washing the screen with kerosene. It may also be necessary occasionally to touch up the edges of the design. When not in use the screens are filed in a horizontal position in racks, Fig. 3, built especially for them.

The cost of a silk screen including the frame, silk and labor is from $20 to $30 depending upon the intricacy of the design. For this reason it is not economical to make a screen unless at least 25 signs are required; when 25 of one sign are required experience of the department has indicated that more signs will eventually be required.

Paper Stenciling Process—The silk screen work is confined principally to making standard signs which are used in large numbers; different methods are used for stenciling signs of which but a few with the same name or legend are required. City name signs are typical of this class. The average number of these signs with the same name is 3 and the maximum number with the same name is 12. There are a total of approximately 1,400 different names. It obviously would be uneconomical to make a screen for each of these names. In stenciling such signs a silk screen stencil is used to stencil that part of the design common to all such as the border and the words "Corporation Limit." Paper stencils are used for the name of the city or town.

The work of making paper stencils and of hand stenciling has been systematized to cut the cost to a minimum. A number of master alphabets of various heights, width of stroke, etc., have been designed and a paper stencil made for each letter. In making a paper stencil the master alphabet is used to stencil the lettering on the stencil paper. The stenciling is done very lightly, being no heavier than is necessary to provide a light outline of the letters. Improper spacing is corrected by re-stenciling, making the re-stenciled letter blacker so that the stencil cutter may know which to cut. Lampblack ground in japan is used as dry as possible for laying out the stencils. Standard detail drawing paper is used for all stencils. This is purchased cut to size so that no trimming is required.

After the stencil is laid out it is cut by hand. Then before it is used to stencil a sign, it is stenciled on paper to make a master stencil for the files. This master stencil is not cut unless the original stencil is destroyed. It is

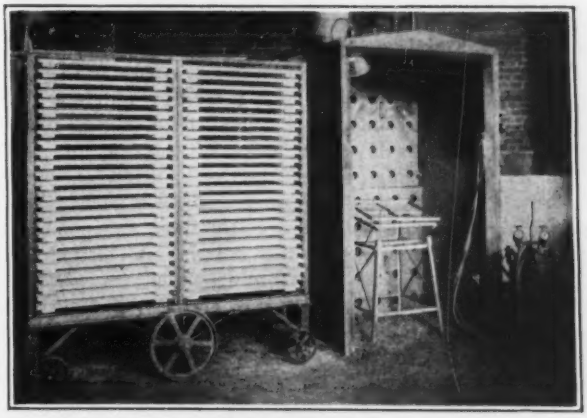


FIG. 4—SPRAY BOOTH, PAINT GUN AND WHEELED DRYING RACK FOR SIGNS

the work of but a few seconds to make a file copy of the stencil after it is cut. Such a copy eliminates the expense of making a lay-out of a stencil more than once. It also solves the problem of filing cut stencils. These are difficult to file unless kept separated, as the ties become entangled and as a result the stencils are torn. All stencils are filed horizontally in specially constructed cases. The stencils are grouped according to the kind of signs, i.e., city name signs, direction signs, etc., and are filed alphabetically. The cut stencils are filed with the uncut

master stencils, the master stencils alternating with the cut stencils.

Stenciling the signs is done by stencil rollers. These are metal 2 in. in width and 1½ in. diameter, covered with short nap plush, and so made that they open up. When opened the plush can be removed and a new piece attached which is held in place when the roller is closed. The stenciling is done by rolling the stencil roller over a small amount of the paint spread on a piece of glass or a metal sheet, then passing the roller over the stencil on the sign.

After the sign is stenciled the ties are "cut in" with a small flat brush as soon after stenciling as possible. It has been found best to cut in the ties before the paint in the rolled stencil has dried. If the paint in the lettering is permitted to dry before the ties are filled in the brush work will not blend with the rolled work and the ties show very plainly, spoiling the appearance of the work.

The use of hand cut stencils does not of course compare in economy with the use of silk screen stencils. The greatest item of cost with paper stencils is laying out and cutting. The next most expensive item is the filling in of the ties after the sign is stenciled. However, paper stencils are used only when a few signs of each kind are required. In such case the cost of silk screen stencils would be excessive per sign. By using paper stencils experienced sign painters are not necessary. Stenciling by paper stencils also is more rapid than hand work and is therefore more economical.

Making the Sign Boards—All signs except route markers and detour markers, are made of redwood because of its low cost and adaptability to sign work. The redwood is purchased in Linderman boards made from short length stock by machinery which turns out sheets or boards of the required size all ready tongued and grooved with the joints glued. The cost of boards made in this manner is less than one-half the cost of pine boards. The boards are purchased ½ in. oversize. The battens for the boards are trimmed to size and are received unattached. The department maintains its own woodworking shop where the boards are assembled, trimmed to exact size, sanded and the battens attached ready for painting.

Painting and Drying—All boards are given three coats of paint on the face and two coats on the back; all paint is applied by spraying. The spray equipment consists of an air compressor with a capacity of 28 cu.ft. per minute operating two spray guns. The compressor is of greater capacity than is actually needed but this capacity was installed to permit of anticipated future increase in the number of guns operated. All spraying is done in special booths (Fig. 4) which are equipped with exhaust fans. Two booths are used.

All signs are handled on specially built steel sign racks on wheels. The racks are filled at the spray booths as the first coat is applied and the boards remain on the same racks throughout their progress through the shop. After a rack is filled with first-coated boards it is moved aside until the boards are dry and is then returned to the spray booths for the second coat, etc. A rack is not emptied until the signs it carries are ready for shipment.

To insure uniformity in the quality and colors of the paints they are made at the sign shop. The equipment, Fig. 5, consists of two 20-in. stone mills and one 15-gal. mixer. In addition there is one 10-in. stone mill and 2½-gal. mixer for making experimental batches. As the paints made are produced on a very small scale as compared with commercial paint manufacture no particular saving is effected in the cost per gallon. However, as only high-grade pigments and oils of assured quality are used it is felt that an indirect saving is made by the resultant uniformity in the quality, working characteristics, and longer life of the paints used. If it were possible for the department always to purchase its paint from the same manufacturers there would no doubt be equal assurance of quality in the paints furnished. Under the system of purchasing on competitive bids which is in vogue in public work, however, it is difficult to explain the reasons for passing up a low bidder as to whose product there are reasonable grounds for doubt. Experience of an unsatisfactory nature in the purchase of paints led to the installation of paintmaking equipment, and as a result all paint troubles have been eliminated.

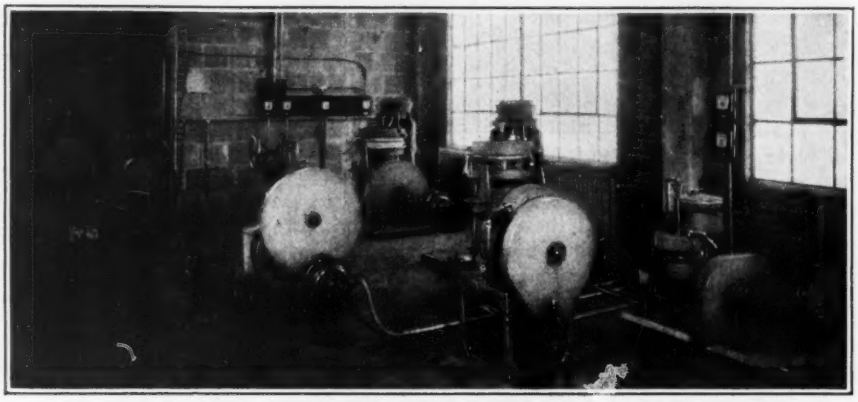


FIG. 5—PAINT GRINDING AND MIXING EQUIPMENT

The paint shop is 80x200 ft., occupying the entire second floor of the recently completed two-story central garage and paint-shop building (Fig. 6) at Columbus. This building is of the modern factory type of fireproof construction. In the design of the paint shop special attention was devoted to ventilation and lighting. The ventilating system is of the forced draft type, the air being exhausted by two fans through ducts with vents near the floor. Overhead lighting is provided by five skylights.

The garage, machine shop and woodworking shop are on the first floor of the building. The woodworking shop, which makes all the sign boards, is adjacent to the elevator, so that the boards may be taken to the paint

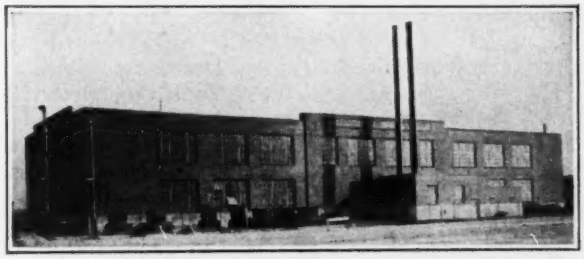


FIG. 6—CENTRAL GARAGE AND PAINT SHOP AT COLUMBUS

shop with the minimum amount of handling. Unpainted sign boards when received from the woodworking shop are stacked on one side of the paint shop adjacent to the elevator, which is at the side of the building The work is so laid out that the boards travel around the building and back to the elevator in going through the various stages of painting.

Practically all signs are delivered to the division headquarters by truck. Owing to the central location of Columbus it is possible for the truck to make the trip to any division headquarters and return in one day. A two-ton truck with a stake body is used for delivering signs, and for general hauling. Shipments are so arranged that a maximum load of approximately 375 signs is always shipped. Shipment by truck speeds up deliveries and obviates the necessity for building crates for the signs. The signs are crated in bundles of four by tacking strips on the edges to hold them apart so that the faces will not be marred.

A practical painter of several years experience is in immediate charge of the shop. He mixes all paints used and superintends all work of the shop. One man who has had signpainting experience makes all the silk screens and lays out all paper stencil work. The remainder of the personnel is unskilled labor. Skilled labor is not needed, as practically all operations have been reduced to a mechanical basis.

Economics of Using Local Materials in Road Building

Purposeful Development of Near-by Gravel and Stone Deposits in Wisconsin Has Cheapened State and Local Road Work

By C. R. Stokes
Materials Engineer, Wisconsin Highway Commission, Madison, Wis.

WHEN considered alone from the standpoint of materials used, a study of the construction and maintenance of an extensive system of highways presents a most interesting problem in engineering economics. A detailed study and analysis of construction costs clearly demonstrates that if a sure and definite saving is to be effected on many projects it is through the careful and judicious use of road materials.

Materials Offer Greatest Savings—Wisconsin, bountifully supplied with road materials in all forms in their natural state, has carefully studied over a period of several years the problem of savings to be made by the use of local materials and has discovered some interesting things.

Undoubtedly one of the most important facts uncovered and the one that was the basis of concerted effort toward saving in construction costs was that it was next to impossible to make a very appreciable reduction in most of the items comprising the cost of a concrete pavement. The cost of cement, joint material and reinforceing is beyond engineers' control except for change in design. Labor costs can be reduced only by a decrease in wage scale or by increased efficiency on the job. Administration, camp loss, water and sundry costs are found to constitute but about 7.1 per cent of the total cost.

In contrast, an analysis of a number of projects shows that the total freight, unloading and truck-haul costs on fine aggregate is approximately 11.5 per cent and on coarse aggregate 17.2 per cent, or a total of 28.7 per cent, of which the freight is 16 per cent and the haul from car to project 12.7 per cent. This freight cost can be reduced by the use of local aggregates and the delivery cost of materials from car to mixer can be reduced by shortening the average haul. At once it is shown that the only item in which an appreciable saving in the cost of construction can be made is aggregate transportation costs.

When concrete aggregate can be produced locally and delivered to the mixer at a cost less than the sum of the commercial material price at the plant plus freight and hauling cost, it is evident that there is a possibility of a reduction in the cost of the road job. Here, then, is good reason why the engineer who undertakes the supervision of a road project should be thoroughly familiar with all available sources of road materials adjacent thereto, and the real basis for such knowledge is through the medium of an efficient road material survey conducted by competent geologists.

Rail Haul Savings—Although very little road material other than concrete aggregate is rail hauled in Wisconsin, the use of such aggregates from local deposits has resulted in large savings. During one season 114 miles of concrete road was built from such deposits, at a saving of practically half a million dollars, or about $5,000 per mile, in freight, unloading charges and truck haul. This seems nearly unbelievable until it is noted that for rail hauls of 5 to 100 miles the cost of freight on aggregate varies from $2,100 to $4,500 per mile of paving. When the attendant unloading charge and possible increase in trucking costs are added, the total forms a surprisingly large percentage of the cost of a mile of paving. For example, the cost of aggregate loaded in trucks at the destination, including freight and unloading charges, on several jobs was found to be $1.74 per cubic yard for a 5-mile rail haul and $2.45 for a 100-mile rail haul.

Assuming that local aggregate was available and could be placed in trucks for 90c. per cubic yard (this figure is rather high), it can readily be seen that there is a saving of 84c. per cubic yard in favor of the local aggregates where the rail haul is only 5 miles. This amounts to nearly $3,000 per mile. The saving would be $1.55 per cubic yard for a rail haul of 100 miles. As a rule the average truck haul is shortened by the use of local aggregate, and still, according to the figures cited, material could be hauled 2 miles farther from a local plant than from a railroad station and still a saving would be effected.

Truck-Haul Savings—Although, as has been stated, rail-hauled materials are seldom used in this state for surfacing, truck haul of materials is an important factor in the construction or maintenance of these lower types of roads. Costs compiled on a number of projects of this nature showed approximately 90c. per cubic yard for crushing, screening and loading; 15c. per cubic yard for spreading, and 88c. per cubic yard for hauling. Transportation was more than 45 per cent of the average cost of material in place on the road; it is the only factor in the cost of surfacing where an appreciable saving can be effected. A reduction would be possible through shortening of the average haul, something that could be determined only by an efficient and comprehensive road-material survey.

Conclusion From Experience—It should be quite clear from these figures that it is poor economy to take bids on a road-construction project involving surfacing of either a high or a low type until a thorough search for local material has been made. The expense of such a

search is so small and the potential saving so large that sound business principles justify the investment. In some quarters the belief has existed that the possible saving to be obtained did not justify the delays and poor quality thought to be involved in the use of local paving aggregates. The successful operation of a large number of local plants in recent years, in which delays have been practically eliminated and the quality of the product has been found satisfactory, has served to remove all, or nearly all, existing doubt. Like any good thing that usually requires time to develop, the production of concrete aggregates from local deposits has developed from a so-called one-horse method to an efficient and thorough operation, requiring expert supervision and proper equipment.

Development of Deposit—After the letting of a paving project involving a local source of material, predetermined by careful investigation, the option on the deposit previously obtained by the engineer is assigned to the successful bidder, and he is then ready to deal with the owner and set his plans in operation for a successful production of material from the definite site. Although the deposit has been selected for him, he has a good-sized problem on his hands in determining first where his plant set-up will be and the type of equipment necessary. If he is able to solve this problem well, he has taken a big step toward insuring himself a successful plant operation.

First of all, a careful investigation of the material site from the standpoint of topography is vitally important. No two deposits are exactly alike, and for this reason the method of operation must conform to the depth, extent and shape of the deposit in question. The estimated depth and extent have been pretty well determined by adequate testpits. Therefore, knowing the number of yards of material necessary for the project, and being able to compute (from screen analysis) fairly accurately the waste to be expected, the contractor should be able to determine how much of a face he will have to develop and how much of an area his operations will have to cover.

If he knows from the test holes that he can expect a good-sized face and if the surface is fairly level, the answer to his problem is easy, and a simple dragline operation will suffice. On the other hand, the topography may be level and uniform but the depth very shallow. Rather than operate a dragline in a deposit of this nature and be continually changing about with its position and anchoring, a small power shovel is sometimes more advantageous and frequently is no more expensive. If water is to be contended with in a shallow deposit, such as has just been described, a cable line bucket will be found to be the best. The ridge-like deposit, or well-known hogback, is another phase of the problem, although usually such a deposit has sufficient depth but a limited extent, which nearly precludes the use of anything save a dragline.

Another very important thing to be considered in the beginning is the water supply for cleansing the material. If a small lake or stream is available near by or up to half a mile distant, water can be pumped directly from such source. Oftentimes, however, surface water is not to be had anywhere near the deposit, and it is then necessary to drill a well or sink a sufficient number of points to produce the required supply. The water question is important, for it is very necessary properly to cleanse the aggregate, and also it materially aids in expediting the screening operations. Usually a 4- to 6-in. pipe line and a centrifugal pump, capable of pumping 500 to 800 gal. of water per minute, will be found necessary.

The actual set-up is the next step to be considered This is dependent upon two things, the topography and the method of loading, whether direct from bins into the trucks or from stockpile. Although the bin method is the cheaper because it involves no rehandling, there are also arguments in favor of stockpiling, the principal one being that it insures continuity of material supply from deposit to paver in case of a breakdown at the aggregate plant. Stockpiling is also dependent upon the topography, for this operation requires considerable space, which may or may not be available. However, when the contractor has determined which method to use, his problem is appreciably simplified, and it is then a case of merely placing his actual set-up in the most advantageous position, considering the shape and size of the deposit.

Experience has shown that the plant proper and the various operating units have been pretty well standardized. The bank-run materials are brought up to a trap or grizzly by the dragline or cable bucket. In either case they are then usually dumped onto an automatic feeder, which, if a dragline is used, generally feeds the material directly into a gyratory crusher. The crushed material is then elevated to the screens either by bucket elevators or belt conveyors. Rotary screens, with round openings conforming in size to the requirements of the specifications, then separate the sand and stone, the former dropping into the washing device and the stone into the bins or to the stockpile. A gravity chute carries the oversize stone back to the crusher.

PLANT AND OPERATION COSTS OF A TYPICAL PLANT
Based on a $20,000 layout and a season's capacity of approximately 40,000 cu.yd.

	Cost Per Cu.Yd.
Stripping overburden (average 3¼ ft. depth)	$0.10
Digging, loading and bringing to plant (labor only)	0.07
Crushing, screening, pumping, washing, elevating and loading (labor only)	0.09
Power for all operations	0.08
Repairs to all equipment	0.02
Royalty paid landowner for pit	0.08
Depreciation	0.07
Supervision	0.01
Taxes and insurance	0.04
Owner's salary	0.05
Interest on capital, $8,000 6 mos. at 6 per cent	0.01
Interest on plant	0.03
Moving and set-up	0.10
Total	$0.75

Several types of sand washers have been used—namely, settling tanks, log washers and a chain and paddle device operating on the same principle as the log washer. A heavy spray of water is found to be advantageous when used on the mixed materials as they enter the first section of screens. On a great many plants this first section is not perforated but is equipped with baffle plates and acts as a scrubber. As for the washing devices mentioned, each has its good and bad points, but the principal requisite is plenty of water, in order that the sand be thoroughly cleansed of any deleterious substance and hence deposited in the bins or on the stockpile as an absolutely suitable product. Some ingenious operators have taken advantage of the washing medium to carry off their waste sand, by merely placing in the trough a baffle or trap which can be used to direct the sand either into the washer or down the waste-water flume.

When a cable line is used to bring the material to the plant, the same general procedure is followed except that the loaded bucket is carried above the ground and the

bank-run material first elevated to the top of the screening plant. It is then screened and the rejected material dropped to the crusher on the ground and then elevated for rescreening. Precaution in regard to using this system is necessary, if large boulders are to be encountered.

Thus experience has shown that several different systems of actual operation may be used, notwithstanding the fact that the units themselves are pretty well standardized. It is largely a case of changing their order so that the maximum efficiency may be obtained. In this connection it might be well to emphasize the importance of sufficient power. A few local plants have been electrically operated, but in most cases the power fuel has been coal or gasoline. Either of the latter is satisfactory, especially if the engines or motors are of sufficient size to produce the necessary horsepower. The contractor can avoid any difficulty in operating power if he will make sure that his design calls for more than enough power to meet his production requirements.

Plant and Operating Costs—Plant costs may differ considerably, contingent upon several things, such as the type of deposit and capacity. The original outlay may vary anywhere from $12,000 to $30,000, with the average probably around $18,000. The accompanying table gives a typical example of plant and operation costs based on a $20,000 layout with a season's capacity of approximately 40,000 cu.yd.

When it is considered that 75c. per cubic yard is about the cost of freight alone for 1 cu.yd. for a rail haul of 15 miles, it is apparent that it is sound business economy, in a state endowed with road materials, to locate and develop local deposits whenever the aggregate can be delivered on the project at a cost lower than that for rail-hauled materials.

Pavement Upkeep for 49 Years in Buffalo, N. Y.

Records Kept Since First Asphalt Pavement in 1878 Give Valuable Figures of Life and Cost for Large Yardages

By George F. Fisk
First Assistant Engineer, Department of Public Works, Buffalo, N. Y.

Greatly condensed from a paper presented at the Asphalt Paving Conference held at Atlanta, Ga., Nov. 28 to Dec. 2, 1927.

BUFFALO has had 49 years experience in laying and maintaining sheet asphalt pavements. The first of these pavements was laid in 1878. The total laid to Jan. 1, 1926, is 8,445,789 sq.yd., at a first cost of $26,624,451.48. Of this pavement there are now in existence 1,230,204 sq.yd. laid prior to 1897 and 2,100,720 sq.yd. laid prior to 1907. Of the total square yards 6,066,121 have been released from guaranty and 2,379,648 are still under guaranty. Altogether 2,307,847 sq.yd. laid since 1878 have been taken up and replaced.

Base Construction—Most of this asphalt pavement was laid on a 6-in. concrete base. Natural cement was used up to 1903, since which time portland cement has been used. On account of traffic conditions it was considered advisable to increase the thickness of the base from 6 to 8 in.; since January, 1926, nothing less than an 8-in. portland cement concrete base has been used on any street, while on streets carrying extremely heavy traffic the base is 9 or 10 in. thick. Approximately 30,000 sq.yd. of pavement having a bituminous base was laid during 1878 and 1881, and this base has since been resurfaced; in some cases the base has outlived two wearing surfaces and in all cases the base still has a further life, the duration of which cannot be determined.

Cost of Maintenance—During the year ended Dec. 31, 1926, the city maintained 3,315,555 sq.yd. of sheet asphalt pavement at a cost of $0.1240 per square yard. The cost per ton for asphalt was $8.10 and for binder $6.70, weighed at the contractor's plant and delivered on the street. The labor cost per square yard on yards repaired was 95c., which includes marking out the repair and cutting it out to the base, removing all old material, painting joints, placing and rolling new material and cleaning up after the repair is complete. The cost of asphalt repairs from 1889 to December, 1925, taken from the records, in 10-year periods, is as follows:

Year	Yards Maintained	Cost per Sq.Yd.
1885 to 1889	28,445	$0.0159
1899	1,749,131	0.0466
1909	1,885,478	0.1101
1919	2,424,426	0.1113
1925	2,553,414	0.1583

The average cost of repairs on sheet asphalt maintained is $0.0613 per square yard for 88,634,812 yard-years of maintenance.

Life of Pavements—The average age of sheet asphalt pavements out of guaranty laid in Buffalo between the years 1878 and 1915 and without street railway tracks is 24.39 years. The average age of asphalt pavements without street railway tracks replaced from 1892 to 1925 is 24.97 years. The average age of pavement replaced, 1921 to 1925, is 31.71 years. The average age of asphalt maintained is 22.95 years.

Black Base Costs—It may be interesting to note the repair costs on those pavements laid on the bituminous base, previously spoken of, although the yardage is not great. During 1878, 9,286 sq.yd. of pavement was laid on a bituminous base. For some reason not determined, this base was resurfaced with asphalt in 1892, the repair costs from 1878 to 1892 being $0.0554 per square yard. This base was again resurfaced in 1925, repair costs from 1892 to 1925 being $1.4435 per square yard. The 3,755 sq.yd laid in 1880 were resurfaced in 1913, repair costs between 1880 and 1913 being $0.7925 per square yard. The repair costs from 1913 to date on this piece of pavement is $0.1620 per square yard. About 7,160 sq.yd. laid in 1880 was resurfaced in 1909, the cost of repairs between these dates being $0.8754 per square yard. The maintenance cost between 1909 and 1926 was $0.2319 per square yard. A total of 8,876 sq.yd. of pavement laid on a bituminous base in 1881 was resurfaced in 1924, the repair costs between these dates being $1.7743 per square yard.

Sprinkler System Operates on 1-in. Service

A fire occurred during the night in a hallway of a hotel just being completed at Springfield, Mass., but was extinguished without any damage by a sprinkler system temporarily supplied through a 1-in. water service. The sprinkler system was being tested in the daytime through the use of small line until a 4-in. permanent supply could be installed.

Pavement Repairs Planned to Reduce Street Closing Time

Plan and Working Schedule Required of Contractors Carrying On Street Subsurface Operations in Akron, Ohio

By E. A. Kemmler
Highway Engineer, City of Akron, Ohio

IN THESE DAYS of traffic congestion the old practice of *laissez faire* in issuing permits for making excavations in the business section of a city must give way to a definite plan, program and supervision for every major project involving temporary inconvenience to business and the general public. In Akron the policy of requiring continuous construction day and night has produced results that are eminently satisfactory. No permit is issued until the plan of procedure, including the maintenance of detours and the setting of a tentative date for completion, is agreed upon. The theory on which such procedure is based is stated in a paragraph of the official information for bidders, as follows:

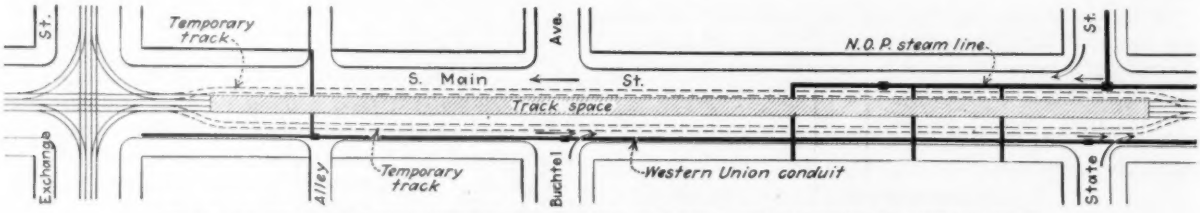
It is the purpose of the city to subject the residents on the street to be improved to the least possible inconvenience, discomfort and injury to business. The general public will be considered as well by providing safe crossings at intersections, by providing detours where possible and by dividing contracts embracing more than 1,000 ft. in length into sections of workable size. Public service companies will be kept informed of the work being done, and ruthless destruction of their property by contractors will not be countenanced. Contractors who are in sympathy with the purposes outlined above, and who are prepared to act in accordance therewith, are invited to submit a proposal for doing the work included in this contract.

As an example of practice an account is given here of a very complicated situation which arose last September, involving construction activities at the same time of three service companies in two blocks of Main St. in Akron. The pavement in the street car tracks on South Main St. between State St. and Exchange St. had become very rough. The street railway company had agreed to renew its tracks and repave between the rails in this section together with the section from Exchange St. to the Erie Belt Line crossing at the Goodrich Tire & Rubber Company. At the same time the Western Union Telegraph Company wished to install a conduit in this section about 3 ft. west of the east curb line and the Akron Steam Heating Company wished to install a steam-heating main on the west side of the street about midway between the street car tracks and the curb together with connections to various buildings.

Inasmuch as this section of South Main St. is in the center of the principal business district of Akron and carries very heavy traffic, it was essential that these improvements be put through in the shortest possible time. To accomplish this it was decided to lay two temporary street car tracks on the pavement on South Main St. as shown by the accompanying sketch. One track was laid about 22 ft. east of the center line of the street in order to allow enough room for trucks to get in alongside the street that was being repaved to haul out dirt and old concrete and haul in material for the new concrete. This allowed just enough room for a truck to get in alongside the Western Union trench. The other temporary track was laid on the west side of the street as close as possible to the west car track. The Western Union Telegraph Company was then allowed to open the trench near the east curb line and the Akron Steam Heating Company to open the trench on the west side midway between the track and the curb. The street was then closed to general traffic, but both sides were kept open for local deliveries.

Both street car tracks were taken up at once, the concrete being broken by a special concrete breaker and excavated with a steam shovel. The rails were then laid on steel ties, welded and set to grade. This was followed with a heavy concrete base. The work of laying the temporary track was started Sept. 19 and the last of the concrete base was laid Sept. 22. This was followed immediately with the track paving, which was completed and the joints poured on Sept. 28.

The grade of the new tracks was from 1 in. to 5 in. higher than the old, necessitating cutting out a strip of asphalt of varying width on either side of the new tracks in order that no sharp breaks might show in the crown of the pavement. The street repair forces of the city started work on Sept. 30 cutting out the asphalt along the east track. The street railway company commenced to operate its cars over the new tracks and to remove the temporary track on the east side of the street on Oct. 1, the concrete base having been allowed a minimum of eight days to set.



PLAN OF THREE SIMULTANEOUS PAVEMENT OPENING OPERATIONS AT AKRON, OHIO

The street repair forces followed up the track removal gang with sheet asphalt along the car tracks and over the Western Union trench, so that the car tracks and practically all of the east side of the street was open for traffic on Oct. 2. The remainder of the work along the west car track and over the Akron Steam Company main was completed on Oct. 4, making a total of thirteen days that the street was entirely closed to through traffic and two days that it was partly blocked. Just one complaint was registered during the thirteen days; it came from the manager of a hotel. The traction company had piled some railroad ties within the narrow strip which was left open for local traffic on the east side, preventing taxicabs from getting out at the north end of the affected section. The obstruction was removed within 30 min. after the complaint was filed.

Credit for this record-breaking achievement is due to E. D. Eckroad, chief engineer of the Northern Ohio Power & Light Company, and H. H. Palmer, assistant engineer in charge of street maintenance, Akron, Ohio.

Bridging the Grand Canyon with a 600-Ft. Steel Arch

Highway Structure on Route North from Flagstaff, Arizona, Will Eliminate Difficult and Dangerous Lee's Ferry Crossing

THE GRAND CANYON of the Colorado River is being bridged by the Arizona Highway Department with a three-hinged steel-arch structure 618 ft. center to center of end pins. This bridge was recently described in *Arizona Highways,* the monthly bulletin of the Arizona Highway Department, by Ralph A. Hoffman, bridge engineer of the department. The bridge is located about 130 miles due north of Flagstaff, Ariz., the nearest railroad point, and will eliminate the present river crossing known as Lee's Ferry, about six miles by road upstream from the site. It will also eliminate the narrow and dangerous piece of mountain road leading down the face of the bluff to the ferry from the Flagstaff side. Lee's Ferry was established in 1871. During a large part of its early existence it was owned by the Mormon Church, but later it was acquired by Coconino County, Arizona, and is now operated under toll by the county. The present road is not now widely known or traveled by tourists, but mostly accommodates traders and others whose business necessarily takes them that way. The bridge will open to automobile traffic a scenic part of the Southwest and provide a new route of north and south travel to points in Arizona and Utah.

A bridge was proposed at the present site many years ago by the Denver & Rio Grande R.R. A highway bridge was first surveyed in 1923, following which Congress passed a bill providing for an appropriation of $100,000 to be matched with state funds for the construction of a bridge. In the history of the project designs have been made both by the Bureau of Public Roads and by the Arizona state highway department, the design of the latter being the one that is now under construction.

The total length of the bridge will be 833 ft. The main span is to be a three-hinged arch of 618 ft. span and 90 ft. rise, c. to c. The trusses have 22 panels at 28 ft., are set on a batter, and are designed for cantilever erection. The

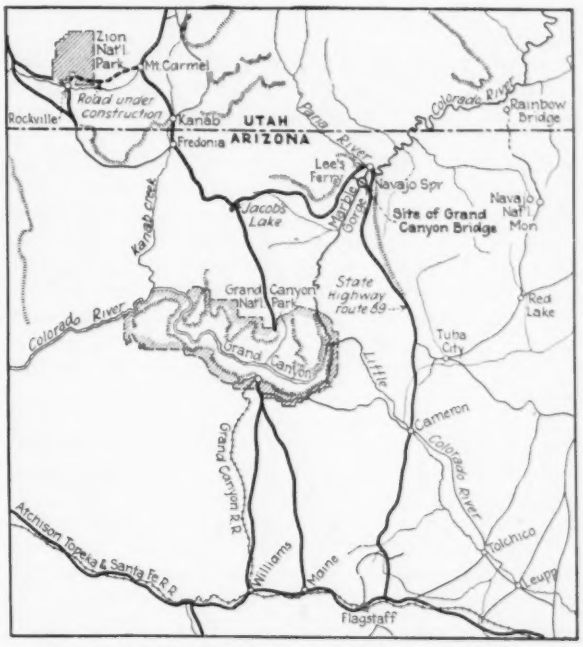


FIG. 1—LOCATION OF 600 FT. STEEL ARCH HIGHWAY BRIDGE ACROSS THE GRAND CANYON

bridge was proportioned for a loading of 60 lb. per sq.ft. on the reinforced concrete roadway, which has a clear width between curbs of 18 ft. The loading of the floor system was taken as one 15-ton truck or two 12½-ton trucks side by side on the roadway. In this floor system, in order to utilize the excess material required in the top chord during erection, the floor load is carried on steel cross-beams at 4 ft. 8 in. spacing directly on the top chord. To reduce the dead load the curb was built of steel angle plates, this built-up member also acting as a stringer carrying part of the floor load.

The bottom chord is a box member built up of eight angles and three plates, the maximum section at the abutment being about 32 in. square, 36 ft. long and weighing about 12 tons. The bottom side of the bottom chord is laced with 6-in. channels. The top chord is also a built-up

FIG. 2—STEEL ARCH HIGHWAY BRIDGE SPANNING GRAND CANYON
Arch is 600 ft. long and crown is 467 ft. above the Colorado River.

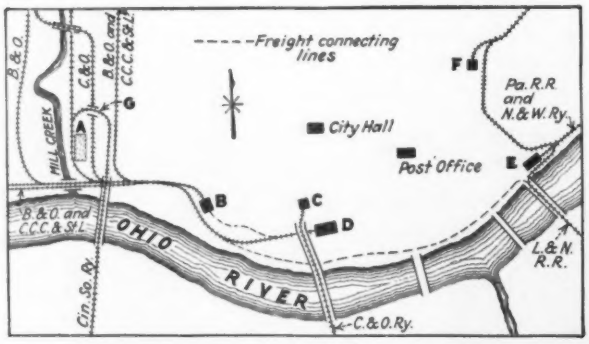
member of angles and plates with batten plates top and bottom.

For the approach spans the top chord is similar to that of the arch. Through this member the entire erection stress, amounting to about 750,000 lb. tension at each truss, is carried back to the erection anchorages. These chords also carry the floor system, on floorbeams similar to those of the main arch. After the erection stress is taken off, the box member is sufficient to carry this floor load in bending, in addition to its direct stress as the top chord of the truss. The bottom chords of the approach trusses and also the diagonals are made from the anchorage eyebars which had been made in exact lengths to fit the truss and used with packing rings in the eyes to compensate for the smaller pins required in the finished structure.

The contract price plus engineering expense totals $341,000. It was based on the following quantities of materials, all of which must be hauled 130 miles by road to the site of the structure: 500 cu.yd. concrete in foundations and deck, 83,000 lb. of reinforcing steel and about 1,875,000 lb. of structural steel; in addition, the price covered 9,000 cu.yd. of excavation. The contractors are the Kansas City Structural Steel Co. The design was prepared by L. C. Lashmet, designing engineer, under the supervision of Ralph A. Hoffman, bridge engineer, Arizona Highway Department. The contract calls for the completion of the structure Sept. 1, 1928.

Railway Terminal Improvements for Cincinnati, Ohio

A NEW union passenger station for the city of Cincinnati, Ohio, is assured by an agreement entered into between the Cincinnati Railroad Terminal Development Co. and the seven trunk line railroads entering the city. This agreement provides for the new passenger terminal, with coach yards and an engine terminal. It does not include freight terminals, but improvements in freight facilities are already planned or under way by some of the individual railroads. The cost of passenger terminal facilities is estimated at about $35,000,000, while the several freight terminal improvements of the individual roads are expected to bring the grand total to nearly $75,000,000.



PASSENGER STATIONS AT CINCINNATI

A. Approximate location for new Union Station. B. Baymiller St. Station: Baltimore & Ohio R.R. and Erie R.R. C. Fourth St. Station: Chesapeake & Ohio Ry. and Louisville & Nashville R.R. D. Central Union Station: Baltimore & Ohio R.R.; Chesapeake & Ohio Ry.; Cincinnati Northern R.R.; Cincinnati Southern Ry.; Cleveland, Cincinnati, Chicago & St. Louis Ry.; Erie R.R.; Louisville & Nashville R.R. E. East End Station: Louisville & Nashville R.R.; Norfolk & Western Ry.; Pennsylvania R.R. F. Court St. Station: Norfolk & Western Ry.; Pennsylvania R.R. G. Loop Approach to Cincinnati Southern Ry. Bridge.

The terminal development company was organized in 1923 by a group of leading citizens, with George D. Crabbs as president, for the purpose of aiding the railways to secure adequate facilities, which were much needed and had been under discussion for several years. The present central station and its approaches are badly congested, while the original freight terminals have become outgrown by modern traffic conditions. Following this agreement with the railways, the Cincinnati Union Terminal Co. was organized in November by representatives of the terminal development company and the seven railroads. Its president is H. A. Worcester, vice-president of the Cleveland, Cincinnati, Chicago & St. Louis Ry. The new company has appointed as its chief engineer, Henry M. Waite, a former city engineer and widely known as the city manager of Dayton, Ohio, for several years; C. A. Wilson, consulting engineer of the terminal development company, is also consulting engineer for the new union station company. An architect will be appointed soon for the design of the station building.

A site has been proposed in the Mill Creek valley, on the west side of the city, outside of but adjacent to the business section. As the Pennsylvania R.R. uses two stations at the east side and does not enter the present union station, some special arrangements were necessary to enable it to reach the new union station. This has been effected by an agreement between the Baltimore & Ohio R.R. and the Pennsylvania R.R., by which the former grants running rights over part of its line and will build additional tracks for the use of the Pennsylvania R.R.

Improvements in freight terminal facilities and engine terminals are under way by some of the individual railroads, including the Baltimore & Ohio R.R. and the Cleveland, Cincinnati, Chicago & St. Louis Ry. (New York Central System.) The Chesapeake & Ohio Ry. is already at work on its new Ohio River bridge and approach lines, estimated to cost $12,000,000, while the Southern Ry. will undertake considerable work as a result of the recent extension of its lease of the Cincinnati Southern Ry.

The Sierra Leone Railway, Africa

Small articulated locomotives and extraordinary thefts of track material are two items of interest in the 1926 annual report of the Sierra Leone Government Railway, which has 338 miles of 30-in. gage. Even in this African colony the automobile has caused trouble to the railway, having so reduced passenger traffic on a line to a residential district (near Freetown, the capital) that abandonment of the line has been proposed. Steel ties are largely used, to which the rails are secured by steel keys or wedges, and during the year some 20,000 of these were stolen, or approximately 84,000 in four years. Other track material disappears in the same way. With ruling grades of 2 per cent, curves of about 400-ft. radius and an axle-load limit of 5 tons, the 23-ton 4:8:0 locomotives could handle only trains of 110 tons and the 20-ton 2:6:2 tank engines only 80 tons. New articulated locomotives of the Garrat type, weighing 45 tons, with 2:6:2—2:6:2 wheel arrangement and the same axle-load limit, can haul loads of 190 tons, with a saving in coal consumption, while the engines are easier on the track and bridges. T. A. Young is chief engineer, and R. Malthus, chief mechanical engineer.

Control and Special Mixtures for Road Concrete

Scientific Design of Concrete Mixes for Pavement Hitherto Neglected—Its Use Increase Strength and Economy—Early Strength Concrete Gives Quick Service

By J. H. Chubb
Manager Service Bureau, Universal Portland Cement Co., Chicago, Ill.

THE paving industry is the biggest single user of portland cement concrete in the construction field. A little over one sack of each four sacks that made up the stupendous shipments of 161,781,000 bbl. for the United States in 1926 went into concrete pavements, or else into the concrete bases under the various types of paving wearing surfaces. Notwithstanding the fact that the paving industry is the biggest user of concrete, it has been among the slowest to adopt and put into use the fundamental principles covering the design of concrete mixtures that have been definitely established by thousands of laboratory tests and by many examples in the field on actual construction work.

Step by step during the past ten years, more and more attention has been paid in concrete paving specifications to the quality of materials, to the proportioning of these materials, to the choice and grading of aggregates, and to the mixing, placing, finishing and curing of the concrete. The specification, however, that has a clause covering the volume of mixing water to use is the exception even today, although it is now definitely known that the amount of water to use in a batch is just as important when considering strength of concrete as the cement content, and more important than the grading and relative amounts of fine and coarse aggregates. The concrete paving specification that does not provide for measuring and controlling the volume of mixing water just as accurately as it does the volume of cement and aggregates in a batch is absolutely worthless as far as controlling the strength of the concrete is concerned.

The marked effect of the volume of water in a batch on the strength of the concrete is clearly shown by the results of tests tabulated in Table I, on eight batches of concrete identical in every respect except the amount of mixing water.

For a given volume of cement, fine and coarse aggregate, there is one volume of mixing water that will produce concrete of maximum compressive strength (the exact quantity of water for maximum strength varies with different mixtures and different materials). Any other volume of water (either more or less) decreases the strength. For the materials and mix used in the concrete of Table I, 6½ gal. total water per sack of cement gave maximum strength at 7 and 28 days. Less water or more water decreased the strength. Notice that 5 gal. of water with this mix and volume of materials produced a concrete having a strength less than half of that obtained with 6½ gal. at 28 days. Too small a volume of water, not enough to make a workable mix, is just as objectionable and has the same effect on strength as too much water.

By a workable mix is meant a concrete that shows a slump of at least ½ in. as measured by the standard slump test, and is not so wet and fluid as to cause a separation of the particles in handling and placing after mixing. Batches C to G inclusive, Table I, are workable; batches A and B are not workable, being too dry; and batch H is so wet as to cause a separation of the materials after mixing and placing and therefore is not workable.

The volume of water per sack of cement is the main factor governing the strength of a concrete for a workable mix; change only the water content and the strength of the given mix may be changed several hundred per cent. In Fig. 1 the results of the 28-day tests in Table I have been plotted. This graph shows what happens to the compressive strength of a concrete when more or less water is used than the right amount, to produce maximum possible strength for the mix given in Table I

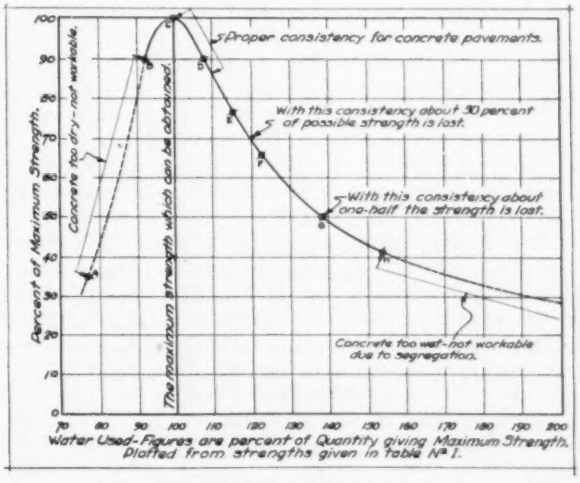

Percent of Maximum Strength.
Concrete too dry - not workable.
The maximum strength which can be obtained
Proper consistency for concrete pavements.
With this consistency about 10 percent of possible strength is lost.
With this consistency about one-half the strength is lost.
Concrete too wet - not workable due to segregation.
Water Used - Figures are percent of Quantity giving Maximum Strength. Plotted from strengths given in table No 1.

FIG. 1—EFFECT OF VOLUME OF WATER ON STRENGTH OF CONCRETE

with the materials used. This graph holds equally as well for other mixes, proportions and materials.

Were the story this graph tells indelibly imprinted on the minds of all those on construction work having anything to do with the mixing, placing or handling of concrete, there would be a marked improvement in the quality and strength of most concrete as now placed. The cry for "more water" would not be so easily complied with or approved, for to do so means accepting and being satisfied with a concrete of inferior quality and strength.

A safe rule to follow in designing a concrete mix for paving work is to use the gallons of water per sack of cement that will give the required strength at a given age with the materials available, and the volume of aggregates that will give concrete of the right slump, not over 1 in. for machine and not over 3 in. for hand finished work.

Strength Not Only Consideration—While concrete for paving work should show relatively high compressive and transverse strengths, the results of strength tests alone might be very misleading and fail to differentiate between a first-class concrete for paving work and one that was entirely unsuitable for such work. Compare

concrete batch 1-a with concrete 6-a—if there is any choice it is in favor of 6-a, because of a little higher compressive strength and modulus of rupture. Concrete 6-a, however, is very much inferior to 1-a for paving work as it is a very much under-sanded mix, would be practically impossible to finish to a satisfactory surface, and even with an excessive amount of labor in placing and finishing would be porous, granular and full of stone pockets. Concrete 1-a would be comparatively easy to place and to finish to a true smooth surface and the resulting concrete would be dense and compact and resist the wear of traffic and action of weathering much better than 6-a. These two examples will suffice to show the danger of relying on strength tests alone for judging quality of concrete. Numerous laboratory tests have developed the fact that concretes having an excessive amount of coarse aggregate develop a high modulus of rupture which may be increased at the expense of compressive strength, workability and density, all of which are important factors in considering concrete for paving work.

Table II shows the results of tests made to determine the compressive strength and the modulus of rupture at 3, 5 and 7 days of concretes such as are commonly used for paving and highway work, 1:2:3½ mixes. For comparison are shown the results of tests on better grades of concrete, 1:1½:2½ and 1:1.2:2, and also on some special mixes, 5-a and 6-a which are introduced to show, as pointed out above, that a high modulus of rupture does not necessarily mean a good grade or quality of concrete. The marked effect on the strength and slump of concrete produced by changing the water content per sack of cement for the same mix and for different mixes is shown. The table also shows the quantities of materials for a cubic yard of concrete and comparative cost figures in

TABLE 1—EFFECT OF VOLUME OF WATER ON STRENGTH OF CONCRETE

(All 1:2:4 Mixes)

Batch	Water, Gal. per Sack	Slump, Inches	Compressive Strength, Lb. per Sq.In. 3 Days	7 Days	28 Days
A	5	0	990	1,460	1,630
B	6	0	2,100	2,820	4,160
C	6.5	¼	1,840	2,850	4,640
D	7	1¼	1,630	2,370	4,180
E	7.5	4	1,290	2,150	3,560
F	8	6½	980	1,560	3,180
G	9	7	620	1,100	2,250
H	10	7	440	770	1,910

the last two columns, that are seldom considered but that it is believed could be used to advantage in deciding on the quality of concrete to use in a particular piece of work.

Select Before Building—A series of tests similar to those tabulated in Table I should be made *before starting* important construction work, so as to determine the best and most economical concrete that can be produced with the materials available to meet the conditions and requirements of the work. Having determined by actual tests what strength may be obtained at different periods with materials available, and having designed the concrete to meet the requirements of the work, it is an easy matter to obtain the pavement cross-section necessary to safely carry the specified wheel load at a given age.

The thickness of the pavement slab, for a distance of at least 2 ft. from any unsupported edge over which maximum wheel loads pass, should be determined by the following formula:

$$T^2 = \frac{3P}{F}$$

in which T = thickness of slab in inches at outer edges
P = maximum wheel load in pounds
F = one-half the modulus of rupture of concrete as determined by tests of the concrete to be used in the work.

The thickness of the slab at a distance of 4 ft. from an unsupported edge may be reduced to 0.7 T. This would make a thickness of T for the edge strips 2 ft. wide, a thickness of 0.7 at 4 ft. in from the edges, and 0.7 T at the center.

A Specimen Case—Assuming a maximum permissible wheel load of 12,000 lb. the edge thickness for a 20-ft.

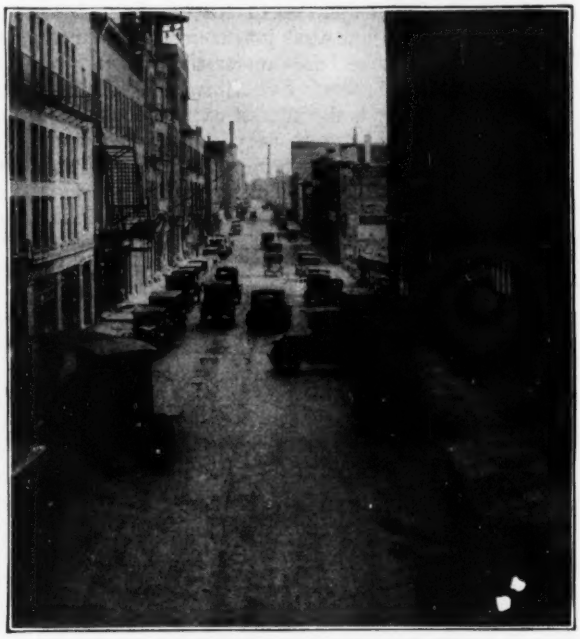


FIG. 2—STREET OPENED IN FOUR DAYS BY CONCRETE CONTROL, DULUTH, MINN.

road to be opened in 7 days with concrete 1-a (Table II) would be 9.93 in. and the thickness in four feet 6.95 in. This is assuming first-class control over the proportioning, mixing and placing of the concrete and satisfactory curing conditions as to temperature and moisture for the first 7 days. The cost of materials for the concrete for 100 ft. of road would be $292.34 (48.4 cu.yd. × $6.04). If about 20 per cent more water is used per sack of cement, concrete 1-b would be obtained and as a result only of this additional water the road section would have to be 11.24 in. thick at the outside, 7.87 in. at 4 ft. in from the edge, and the cost of materials would be $320.03 per 100 lin.ft. of road. Figuring the same way but using concrete 1-c, having 40 per cent more water than 1-a, the edge and center thicknesses would be 12.93 in. and 9.05 in., and the cost for materials for concrete for 100 ft. of road would be $356.06 (5.65 × 63.02 cu.yd.)

The cost of finishing concrete would be about the same in each case, although concrete 1-c would be too wet to use except on a road having a very flat crown. The three roads would all have the same strength at the end of 7 days and would all have the same load-carrying capacity at the end of that period, but the one built with concrete 1-a would show the least wear under traffic and would require less maintenance cost, because it is made of better, stronger, denser concrete and is better

in every respect than the 1-b concrete road, which in turn would be better than the 1-c road.

Suppose instead of concrete 1-a, 1-b and 1-c, the road is built of concrete 3-a, the edge thickness would be 9.31 in., the center thickness 6.52 in. and the cost of materials per 100 ft. of road $307.67 ($6.78 × 45.38 cu.yd.). Concrete of this quality would cost about the same to mix and place per cubic yard as the other concretes, but would require less labor for finishing because of the character of the concrete. The resulting road would be better than the other road because concrete of better quality was used, concrete with higher earlier strength and also higher ultimate strength.

From these examples it will be seen that to construct a road having the same strength at 7 days using concretes, 1-a, 1-b, 1-c and 3-a, would require $292.34, $320.03, $356.06 and $307.67 respectively for materials. This difference in material cost, however, does not represent difference in cost of concrete placed on the road, for while cost of finishing per square yard of surface would be about the same, the cost of mixing, handling and placing the different volumes of concrete required per 100-ft. section of road, namely, 48.4, 54.8, 63.02 and 45.38 cu.yd. would reduce the cost of mixing and placing (probably in direct proportion to the volumes). The road constructed of the 1-b concrete requires 497 cu.yd. more concrete per mile than does the 3-a concrete.

Notice particularly that to produce a road of the same strength with concrete 1-a and concrete 1-c, which is the same as to mix but contains 40 per cent more water, that edge thickness must be increased by 3 in. and cubic yards of concrete required per 100 ft. by 14.6 cu.yd. This emphasizes the fact that the use of an unnecessarily large volume of water is expensive if the required volume of concrete and increased thickness are used to make up for the loss in strength of the poorer quality concrete.

Early Opening—That it is practicable to obtain concrete of the required strength for use in constructing pavements to be opened to traffic at a given age, has been demonstrated during the past two years by numerous examples in the field.

Fig. 2 shows a mile of concrete pavement 33 ft. wide placed in 1926 on a heavy-travel street in Duluth, Minn. The specification used in Duluth prior to 1926 required that concrete pavements be closed to traffic for at least 14 days when the minimum air temperature was 50 deg. and for one additional day for each degree below 50 deg. F. It was appreciated, as should always be the case, that variations in temperature affect the rate of hardening and strength of concrete. The lower the temperature the lower the strength at the end of a given time. It is not possible to control weather, but it is possible to control quality and strength of concrete to a large degree, and by making tests of the concrete as placed to determine definitely its strength at the end of any period. The concrete in this pavement that was opened to heavy traffic in 4 days, differed from that of other concrete pavements laid there and closed to traffic for at least 14 days, by about one sack of cement per cubic yard of concrete, sufficient water to produce a slump of not to exceed 1½ in. instead of 2 in., and 1½ minutes mixing time instead of 1 minute. Instead of arbitrarily setting a minimum of 14 days before the pavement could be opened to traffic, the opening was governed by the time it took test cylinders of concrete to withstand a compressive strength in excess of 2,000 lb. per square inch. Test specimens were made on every day that concrete was placed, and were subjected to the same temperature, curing and weather conditions as the pavement. It was found that at the end of 4 days the average compressive strength of concrete was 2,130 lb. per square inch, making it practicable to open the different sections of the pavement on the average at the end of 4 days instead of waiting at least 14 days, as required usually in paving specifications. Here they not only secured a pavement that was opened to traffic in 4 days, but also one that is of better quality, which means added wear and life—at an additional cost that was insignificant considering the saving in time of at least 10 days to those waiting to use the pavement.

The data presented, covering laboratory results and actual field construction experiences, show that it is practicable to obtain and to use high-early-strength concrete for paving work. From an equal load-carrying or strength basis, such concrete is but little, if any, more expensive than ordinary concrete, and in addition to insuring a pavement that can be opened to traffic much earlier than is the usual practice, a permanently better and stronger pavement or concrete base is secured.

TABLE II—STRENGTHS, COSTS AND WORKABILITY OF DIFFERENT MIXES COMPARED

Batch	Mix	Water, Gallons per Sack Cement	Slump, Inches	F.M. Mixed Aggregate	Quantities One Cu.Yd. Concrete: Cement, Sacks	F.A. Cu.Ft.	C.A., Cu.Ft.	Compressive Strength, Lb. per Sq.In.: 3 Days	5 Days	7 Days	Modulus of Rupture, Lb. per Sq.In.: 3 Days	5 Days	7 Days	Cost Materials per Cu.Yd	Cost per 1,000 Lb. Compressive Strength, 7 Days
1-a	1:2:3	5.83	1	5.42	6.07	12.14	18.21	1,890	2,790	3,280	510	660	730	$6.04	$1.84
1-b	1:2:3	7.00	6	5.42	5.87	11.74	17.61	1,190	1,760	1,920	350	490	570	5.84	3.04
1-c	1:2:3	8.18	8½	5.42	5.67	11.34	17.01	760	1,100	1,350	240	370	430	5.65	4.19
2-a	1:2:3½	5.93	1	5.58	5.67	11.34	19.85	1,840	2,790	3,100	480	670	700	5.86	4.90
2-b =	1:2:3½	7.12	6	5.58	5.49	10.98	19.22	1,270	1,710	1,930	380	490	550	5.66	2.94
3-a	1:1½:2½	4.80	1	5.54	7.36	11.04	18.40	2,930	3,780	4,220	680	730	830	6.78	1.60
3-b	1:1½:2½	5.88	7½	5.54	7.09	10.64	17.73	1,820	2,420	2,690	520	610	710	6.54	2.42
4-a	1:1.2:2	4.24	1	5.50	8.73	10.48	17.46	3,730	4,320	5,090	760	860	950	7.52	1.48
4-b	1:1.2:2	5.08	8	5.50	8.44	10.13	16.88	2,330	3,210	3,540	660	690	750	7.28	2.05
5-a	1:1.6:3.7	5.83	1	5.81	5.74	9.07	21.12	1,900	.....	3,250	450	...	760	5.81	1.80
6-a	1:1.1:3.9	5.16	1	6.13	6.05	6.84	23.90	2,140	.....	3,430	600	...	910	6.06	1.76

Note: F.A = Fine aggregate graded 0 to ¼ in. with F.M. of 3.07. Unit cost materials cement $2.50 per bbl. C.A. = Coarse aggregate graded ¼ in. to 1½ in. with F.M. of 7.00. F.A. and C.A. $2.00 per cubic yard. F.M. = Fineness modulus.

Effect of Flood on Water Distribution System

During the recent severe flood conditions in New England, the Connecticut River at Springfield, Mass., rose to such a height in the northern portion of the city that it overflowed earth dikes and inundated a section of low land. The moisture soaking into the ground weakened the supporting value of the soil in places and permitted the water pipe to settle which resulted in three breaks in the cast-iron mains. A 42-in. main supply line for the city passes through the area which was flooded but was apparently not damaged in any way.

Progress on Central Highway of Cuba During 1927

Lack of Engineering Organization Delayed Work Road Materials Supply Big Problems Construction Now Active

By Horace W. Ash
Vice-President, Warren Brothers Co.,
Boston, Mass., General Contractors

THE central highway of Cuba put under construction in 1927 extends virtually the whole length of the island from Pinar del Rio to Santiago, 705.6 miles. The road is paved its full length 20.66 ft. wide with Warrenite Bitulithic on a concrete base with thickened edges. Two contracts were awarded, one to the Warren Brothers Company, of Boston, Mass., for about 70 per cent of the line and one to the Associated Cuban Contractors, Inc., for the remainder. An account of the contracts, the plan of financing the work and the general construction conditions was given in *Engineering News-Record*, April 7, 1927, p. 558.

The contract for construction in the provinces of Pinar del Rio, Havana, Camaguey and Oriente was signed with the Warren Brothers Company Feb. 19, 1927. Prior to the advertisement for bids the government had made preliminary surveys on most of the line of the new road by contract with various engineers, who made the survey, studies and plans for a fixed sum of $350 per kilometer. When their work was finished, therefore, their functions ceased, leaving the government at the time of the signing of the contract without any special engineering organization to take care of the actual surveys and execution of the work, and it was not until about April 1, 1927, that the appointment of an engineering personnel was finally approved by the government.

FIG. 1—BULL TEAM HAULING GASOLINE FOR POWER SHOVELS
Twelve-head bull team hauling trailers on crawlers found economical on new grade wet and muddy from heavy precipitation of rainy season.

This fact, coupled with the natural loss of time due to inducting the engineering force into office, delayed the actual starting of the work at nearly all points until about May 1. However, the official start, which was made in order to comply with the conditions of the contract, was made in all of the provinces on March 2, 1927. Unfortunately, the actual commencement of operations on a large scale was practically coincident with the beginning of the rainy season, but notwithstanding the handicaps with the rains the progress has been considerably greater than the program laid out at the beginning of the work.

Construction Organization—The entire accounting, engineering and executive work in connection with the contract is centered in Havana. For convenience of operation the contract has been split up into five divisions, each operated as an independent unit under the direction of the Havana office. The division headquarters are located in San Cristobal, Pinar de Rio Province; Hoyo Colorado Havana Province; Jamaica, Havana Province; Camaguey, Camaguey Province; Bayamo, Oriente Province, with subdivision headquarters at Cocacum, Oriente Province, and Palma Soriana, Oriente Province. The size of the subdivisions and the location of the headquarters were determined after careful consideration of the amount and character of the work to be done in the different sections of the highway, the location and character of the material supplies, and the need of more rapid work in some sections due to density of population and the amount of money assigned by the contract from the public works fund to the various sections.

Initial Problems—The most urgent and immediate problems confronting the contractors were the investigation of sources of supplies of sand, stone and gravel and the necessity of attacking the heavy grading as soon as possible so that the deep fills might have ample opportunity to settle before the roadway was built. In regard to the material situation, the only crushed stone available in sufficient quantities to be a factor on any of the work was centered in two quarries very close together in the town of Camoa in Havana Province, and the sand situation was such that the only available supplies were in the shape of calcareous sand from the shores in the immediate vicinity of Havana and siliceous sand located in small deposits along the various streams in the Province of Pinar del Rio. This situation necessitated a very thorough geological survey before any definite plans could be made for outlining the progress of the work. The problem was further complicated by the fact that the railroads in Cuba cannot be depended upon to any great extent, due to extremely high freight rates and uncertainty of service. These problems have now been worked out definitely for practically the whole length of the highway, and sand and stone have been found in workable quantities in many places where up to that time they were not supposed to exist.

Bridge Work—Another factor, which is of considerably greater importance on this work than on an ordinary road job in the States, is the question of concrete

bridges and culverts and steel bridges. The rainfalls are extremely heavy and the runoff very rapid, so that in some places there are many substantial concrete bridges of span ranging from 1 m. to 30 m. to take care of the drainage. One section of 20 miles averaged four of these bridges per mile, and since the location and the size of these bridges had been determined in only a preliminary manner, a great deal of concentrated attention was necessary to get this portion of the work under way quickly and on a large scale in order that it might not interfere with the following operation.

Progress and Methods—The rainy season had practically stopped by the first of November, and up to that time slightly more than $3,000,000 worth of actual construction work on the highway had been completed. In addition there had been completed about $500,000 worth of work in opening up quarries, sand deposits and gravel pits, and in building roads out from these various deposits either to the highway or to the railway shipping points.

The work on the highway in November amounted to approximately $1,000,000; the schedule calls for an average of $1,250,000 worth of work each month until the job is completed. The materials are handled principally by hauling, the bulk of which is done with trucks, although where time and conditions will allow materials and excavation are handled by bull carts, the cheapest means of transportation for short distances where it can be used.

In the matter of labor, the contractors are limited by the contract as to the number of foreign employees that can be used, and scrupulous care has been exercised

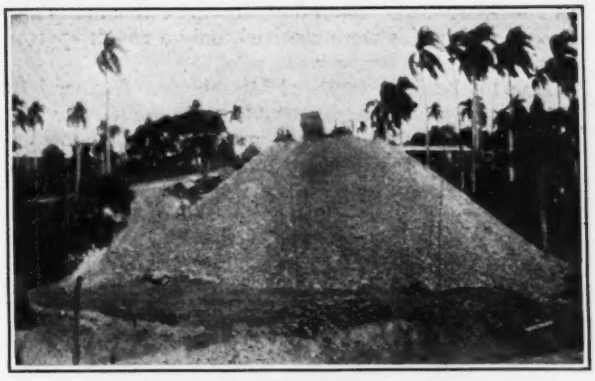


FIG. 2—FILL AT AGUACATE BRIDGE SITE

to keep within the limits prescribed. Of the common labor, about 75 per cent of the employees are Cuban, and practically all of the others are Spanish. In regard to the skilled labor, a certain number of Americans were necessary to educate the natives to the various tasks, but the growth of the organization at the present time is being made almost entirely in the direction of utilizing native help, with very satisfactory results. The native and Spanish laborers are more easily taken care of in camps than is the laborer in the United States. The barracones in which they live are of very simple construction, made by covering a wooden skeleton with palm leaves; the men sleep in hammocks stretched between the uprights forming the sides of the barracones. In the smaller camps many of the men do their own cooking. In some of the larger ones the cooking is done by someone hired for the particular purpose; but

FIG. 3—A CONSTRUCTION CAMP ON BRIDGE WORK FIVE MILES AHEAD OF GRADING

in all cases the food is very simple and the culinary equipment is of a decidedly more primitive nature than is required by statute in most of the states.

The methods used in different classes of work vary little from common practice in this country with the exception that considerable of the grading work, especially where it consists of borrow from the ditches and shallow cuts with short end movement, is done by station work and is done extremely well.

Direction—The department of the government handling this project is under the very able direction of Señor Manuel A. Corroalles, chief engineer of roads and bridges. The contractor's interests are under the direction of the writer, with William C. McDonald general manager of the Cuban operations, Ira B. Safford assistant manager, and William C. Rich Cuban treasurer. The superintendents of the district operations are: Fred A. Fairy at San Cristobal, W. H. Walsh at Hoyo Colorado, Fred A. Jones at Havana, E. Bowker at Jamaica, A. B. Ordway at Camaguey. Earl J. Wood at Bayamo, and A. B. Harr at Palma Soriana.

Unusual Difficulties in Desert Paving Job

A 7-mile concrete paving job was completed recently on the Mountain Springs grade between the floor of Imperial Valley in California and the summit of the divide, El. 1,753, on the state highway toward the Coast. In reviewing difficulties encountered on this job, the *California Constructor*, published by the Southern California Chapter of the Associated General Contractors, states that the route followed "is covered with boulders, many as large as houses, and seemingly the area is a rattlesnakes' paradise. . . . Even dirt for the subgrade had to be imported. In one storm more than 14 in. of rain fell within 16 hours. More than a week was lost because of winds that blew fines and cement out of the skip while the mixer was being charged, and then a series of minor earthquakes shook down large quantities of rock into the roadbed. Temperatures of 115 deg. were not unusual." A notable feature of the construction layout was the necessity of piping water 16 miles to supply the job. At the source the pipe line was 5 in. in diameter and the required pressure was maintained by several booster pumps along the line. Contract for the job was carried out by the Jahn & Bressi Construction Co.

Rapid Repaving of a Busy St. Louis Thoroughfare

Wood Block Replaced With Granite Blocks—Testing and Removing Old Concrete by Scarifiers—Early-Strength Cement Used in Concrete Base Laid at Night Only

By H. Shifrin
Assistant Chief Engineer, Division Sewers and Paving,
St. Louis, Mo.

BETWEEN 1902 and 1920 creosoted wood-block pavement was laid on some of the heaviest traveled streets of St. Louis. Among the streets was Washington Ave., which was reconstructed from Fourth St. to Twelfth Boulevard in 1910, from Twelfth Boulevard to Eighteenth St. in 1912, and from Eighteenth St. to Jefferson Ave. in 1916. The foundation from Fourth St. to Eighteenth St. consisted of between 5 and 6 in. of 1:4:7 portland cement concrete laid on top of the original base of 6-in. natural-cement concrete. The base, in the section from Eighteenth St. to Jefferson Ave., consisted of 5 in. of 1:3:6 portland cement concrete over the old natural-cement base.

Washington Ave. runs through one of the most important retail sections of the city from Fourth St. to Tenth St., then to Eighteenth St. through a busy wholesale jobbing district, and on to Jefferson Ave. through a manufacturing section. The traffic is very heavy, consisting of trucks, automobiles and double-deck buses equipped with solid tires. The roadway between curbs varies from 50 to 60 ft. in width and carries double street-car tracks in the center.

FIG. 1—TYPICAL VIEW OF OLD WOOD BLOCK PAVING ON WASHINGTON AVE., ST. LOUIS

Experience in St. Louis with wood block under such traffic, especially since modern, rapidly moving rubber-tired vehicles have replaced slow-moving, narrow steel-tired ones, has resulted in the adoption of a policy of replacing wood blocks as rapidly as possible. The climatic conditions of St. Louis are such that the blocks dry out during certain periods of the year and then swell up when heavy precipitation occurs, causing buckling of the surface and the floating and carrying away of the blocks. Even with unusually high maintenance expenditure it has been found practically impossible to keep a satisfactory surface on Washington Ave. A typical view of the old wood-block paving is shown in Fig. 1.

In 1926, the Director of Streets and Sewers requested that Washington Ave. from Fourth St. to Jefferson Ave. be reconstructed. Due to street-car tracks, and also due to the shallow water line at the curbs, only two methods could be considered in the reconstruction. The first was to remove the existing wood-block paving and bedding course to the old concrete foundation; remove the defective portions of the existing concrete base and replace with new concrete; lay a bedding course of ½ to 1¼ in., depending upon the elevation of the old concrete, and place a new wearing surface of 4-in. granite block filled with asphalt mastic. The alternative method was to remove the existing wood-block wearing surface and bedding course and so much of the old concrete base as to permit at least 5 in. of new concrete to be laid on the better portions and 8 in. on the defective portions, and lay an asphalt pavement, or a wearing surface of some other bituminous type, over the new concrete base.

Test holes dug with picks and crowbars through the old concrete indicated the concrete to be non-uniform in character, with apparently a large portion of the base between Fourth St. and Eighteenth St. in excellent condition. However, they showed that the actual yardage of the existing concrete which might be re-utilized could be determined only after the wood-block surface and bedding course had been removed and the whole tested as later described. Therefore, for the estimated quantities on which bids were received, only a rough approximation of new concrete was made.

Due to the importance of Washington Ave. and the nature and volume of traffic, and also to the narrow lanes to which traffic is restricted by the street-car tracks, it was decided to reconstruct the street with 4-in. granite block. To reduce financial loss and other inconveniences to both property owners and the public, all means for speeding up the work and closing the street for the shortest possible time were adopted. Early-strength cement was specified, and definite plans for the manner and time of the various depths of reconstruction were set out. As the cost of such reconstruction would be above normal, sufficient bond-issue funds were set aside to pay 35 per cent of the total cost; the remainder was assessed against the benefited property (in this case little other than abutting property).

The street was divided into three sections identical with the limits of the contracts of the original reconstruction with wood-block paving, and three separate specifications and contracts were drawn up for the work. Those for the two eastern sections (Fourth St. to Eighteenth St.) were identical, and contained the following unusual requirements:

The contractor was not permitted to begin work on the reconstruction of either section until the granite blocks (obtained from Georgia) required for the paving of one side of the roadway between the curb and the edge of the toothing along the tracks were delivered. Work was then allowed to be started on one side of the roadway only, and at no time were more than three city blocks, and on only one side of the street, to be closed to traffic. Upon the completion of one side of the road-

FIG. 2—REMOVING WOOD BLOCK AND SCARIFYING OLD CONCRETE BASE

way throughout the limits of the section, closing of the opposite side was not to commence until the blocks required for that side had been stored.

The sequence of operations to be followed and the portion of the work to be performed only at night were definitely prescribed. The wood-block wearing surface was to be removed during the day. The first night thereafter, and then during both day and night thereafter, a 10-ton three-wheel roller with a scarifier attachment, the prongs of which were 3 in. or more in length, was run over the surface of the old concrete base both as a test of the concrete and as a means of removing concrete so defective as to crumble under the scarifier (foreground of Fig. 2). Where the surface of the concrete was at the proper elevation and remained firm and was not broken up by the scarifier, it was used as the base for the new pavement. The defective sections were removed to the depth loosened by the scarifying, and repeated scarifying and removal continued until the concrete was removed to the depth desired. Where scarifying was impossible due to valve boxes or manholes, and also adjacent to the curb or toothing along the rail, the work was carried out with hand-picks, crowbars or pavement breakers.

The specifications required that the scarifying and removing of the concrete be carried out at night only, as it was assumed that the removal of concrete in this manner would create a serious dust nuisance. As a matter of fact it did not, and scarifying and removing of concrete were permitted during all hours of the day and night.

As soon as any considerable area had been prepared for the placing of the new concrete and the subgrade properly shaped up, the new concrete base was to be laid the following night, using an early-strength cement. At the time of writing the specifications, it was assumed that concrete operations would commence on the second night. The concrete base was to be cured for 24 hr. and then the limestone screenings for bedding course and granite blocks were to be hauled in and the pavement laid the following day, which would mean a period of four days from the time that the first block of the street was closed until its completion. The cement was specified thus:

Fineness—The residue on a No. 200 mesh sieve shall not exceed 5 per cent by weight.

Time of Set—The cement shall not develop initial set in less than 45 min. when tested with the Vicat needle, or 60 min. when the Gillmore needle is used. Final set shall be obtained within 10 hr.

Tensile Strength—The average tensile strength in pounds per square inch of not less than three standard mortar briquets composed of one part cement and three parts standard Ottawa sand by weight shall be not less than 325 lb. per sq.in. in 24 hr.

Compressive Strength—The average compressive strength in pounds per square inch of three 6x12-in. concrete cylinders, mixed in the proportions of 94 lb. of cement to 6 cu.ft. measured separately of dry fine and coarse aggregate (the ratio between fine and coarse aggregate desired is approximately two parts of fine and four parts of coarse by volume) and sufficient water to give a slump of the concrete of not less than 3 in., shall not be less than 1,500 lb. in 24 hr.

In the St. Louis district there were several available brands of early-strength cement which complied with this specification. The cement used was manufactured in St. Louis by the Missouri Portland Cement Company and was known as Velo cement. The price was $3.75 a barrel in carload lots, delivered in paper sacks. The specifications for concrete mix required that six sacks of cement be used to each cubic yard of concrete and that the consistency at no time exceed a slump of 4 in. The mixing time for concrete was specified at 2 min. when hauled wet from a central plant or 1 min. when mixed on the street.

No storing of concrete materials was permitted on the

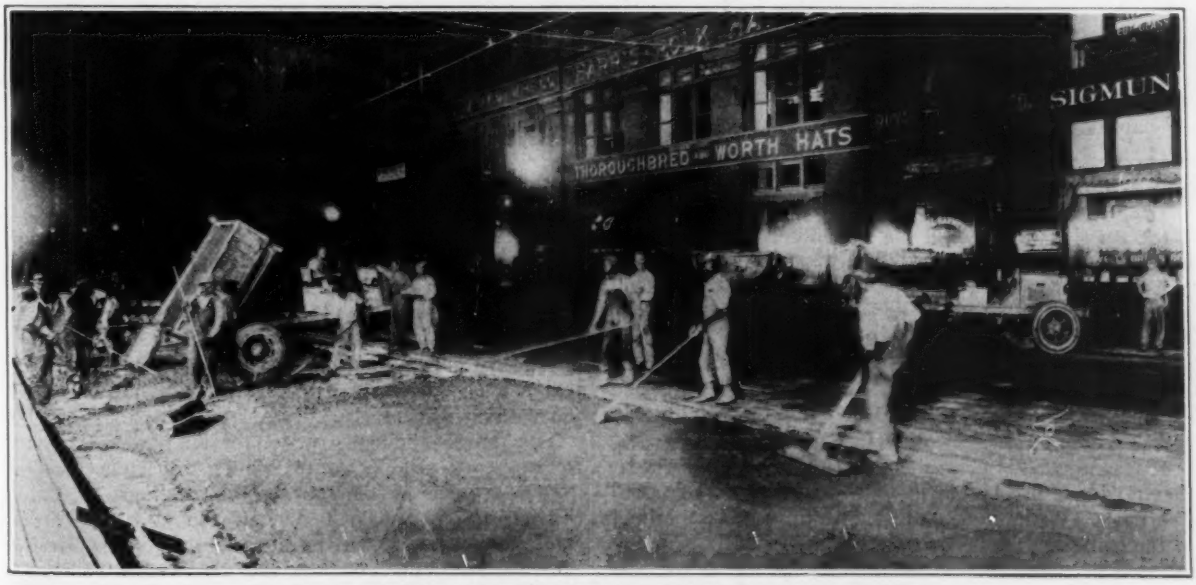


FIG. 3—NIGHT CONCERTING WITH EARLY-STRENGTH CEMENT

job, making it optional with the contractor either to mix the concrete at the central mixing plant and haul the wet concrete in trucks to the site, or else to haul dry batches, mixed in the proper proportions at the material yard, to the mixer on the job. The contractor decided to use wet concrete from a commercial central plant delivered in dump-body trucks (see Fig. 3). The concrete was mixed and placed in the street at night only, commencing not earlier than 6 p.m. The average 24-hr. compressive strength of 6x12-in. cylinders of job concrete taken there each night was 2,100 lb. per sq.in. 1,600 to 2,800 range. From cylinders made and cured in the laboratory a 7-day compressive strength of 4,000 lb. was secured and a 28-day strength of 6,230 lb. per sq.in.

This cement acts very much as does portland cement, generating no greater amount of heat during its curing. However, the effect on its strength at low temperature is much more marked. The minimum 24-hr. strength was obtained from three cylinders poured during a night when the temperature of the air dropped slightly below 60 deg. Below 60 deg. F. such concrete should be cured for at least 48 hr. before the laying of the wearing surface.

The night following the pouring of the concrete, the limestone screenings for the bedding course and the granite blocks were hauled in along the street over the new concrete. Specifications for the granite blocks to be used on this work conformed to the standard granite block specifications with the exception of the depth, which was fixed at $3\frac{3}{4}$ to $4\frac{1}{4}$ in.

FIG. 4—COMPLETED GRANITE BLOCK SURFACE ON WASHINGTON AVE., ST. LOUIS

The following morning the granite blocks were laid and the joints filled with asphalt mastic of equal parts by volume of hot asphaltic cement (having a penetration at 77 deg. F. of between 50 and 60 and a ductility of not less than 50 cm.) and hot fine sand. Hot torpedo gravel was spread over the surface and then thoroughly rolled, making a completed surface as shown in Fig. 4.

It was assumed, when the specifications were written, that no block would be closed to traffic for more than five days. With this in mind, the time limit specified in the contract for the two eastern sections, the yardage on each of which was approximately 10,500 sq.yd. was set at five weeks.

The successful contractor was low bidder on all three sections, and therefore commenced at the western end of the central section, Eighteenth St., with two scarifiers, four compressed-air pavement breakers, one plow, one truck and approximately the following force: Two men removing wood block, which was hauled away by private parties as fast as removed, saving the contractor the cost of hauling and disposing of it; three gangs consisting of one foreman and twelve men, with four 5-ton trucks removing concrete; one foreman and eight men making up the night concreting crew; fifteen pavers laying granite blocks; three asphalt distributor tanks in which the asphalt was kept heated, and one foreman and ten men with three carts, for the spreading of the asphalt mastic filler and torpedo gravel.

Instead of completing this street in sections in accordance with the prescribed time limits, the contractor completed the whole north side of the street from Eighteenth St. to Fourth St. before beginning work on the south side. Separate gangs meanwhile started work on the section from Eighteenth St. to Jefferson Ave., where the contractor was permitted to take up all of one side and do all of the work in the daytime only, using, however, early-strength cement. The average actual time that any one block of Washington Ave. was completely closed to traffic between the limits of Eighteenth St. and Fourth St. was between seven and eight days. This takes into account Saturday afternoons and Sundays, during which time the pavers refused to work, and also all days lost on account of inclement weather, which were very few. At least one day's time on each block could have been saved had it been possible to secure sufficient granite block pavers. In St. Louis these men are unionized and their number is limited.

Work began on July 18 and one side was completed and opened to traffic between Eighteenth St. and Fourth St. on Aug. 18. Work on the south side of Eighteenth St. commenced on Aug. 13 and was completed to Twelfth Boulevard on Sept. 2 and to Fourth St. on Sept. 16. The whole project to Jefferson Ave. was completely paved and opened to traffic on Sept. 21, establishing a record for time in carrying out to completion such a volume of work. The paving was approximately 31,000 sq.yd., and the concrete slightly more than 5,000 cu.yd. The contractor was able to make quite a saving due to the prompt deliveries of the granite blocks by the railroad companies, as after storing sufficient blocks to pave one side of one section the deliveries came in so promptly that it was possible to haul direct from the cars to the job without storing.

The design and construction of all new sewers and paving work are performed under the supervision of the Department of the President of the Board of Public Service, E. R. Kinsey president, and W. W. Horner, chief engineer of sewers and paving. Joseph Kesl & Sons of St. Louis were contractors. Work was under the direct supervision of Alden Chase, engineer in charge of paving, and Fred Winter, district engineer.

Col. Potter Comments on Difference in Cost Estimate of Two Mississippi Flood Plans

Reasons for Differences Between Cost Figure Given in Chief of Engineer's Flood Control Plan and That Given in Mississippi River Commission Plan Outlined by the President of the Commission

TWO plans for controlling the flood waters of the Mississippi River have been made public by the War Department, the first, that of the Chief of Engineers, U. S. Army, which was transmitted to Congress by the President with his approval soon after it convened, and the second, that of the Mississippi River Commission, a revision of its earlier plans for the control of the river, prepared at the direction of the Chief of Engineers following the flood of the spring of 1927. The two reports differ only in a few particulars as far as their physical characteristics are concerned and yet the estimated cost of the work in the Chief of Engineer's plan is placed at $296,400,000, while that of the Mississippi River Commission is placed at $775,000,000. Under the title of "A Startling Discrepancy" *Engineering News-Record* commented upon this difference in cost estimates in its editorial pages of the issue of December 22. As a result of that criticism Col. Charles L. Potter, president of the Mississippi River Commission, has sent the following comparison of the cost figures given in the two plans, with his comment as to how the discrepancies came about. Abstracts of the Chief of Engineer's plan were given in our issue of Dec. 15, 1927, p. 961, and of the Mississippi River Commission plan in the issue of Dec. 22, 1927, p. 1006.

COL. POTTER'S COMPARISON OF ESTIMATES

Chief of Engineers' $296,400,000 plan compared with Commission's $775,000,000 "Comprehensive Plan" for Mississippi Flood Control.

Item	Chief of Engineers' Estimate	Commission's Estimate	Difference
BANK STABILIZATION	$110,000,000	$165,000,000	+$55,000,000

Comments—There can be no definiteness in this figure. The commission believes that, with the addition of 500 miles of bank revetment, to the 130 miles now existing, and with the provision of $15,000,000 for channel regulation, the stabilization of the banks and channel will be practically complete. A lesser amount will partially complete the plan.

LEVEES—MAIN RIVER	$131,900,000	$326,500,000	+$194,600,000

Comments—The Chief of Engineers allows for a levee system "slightly above" the grade of the maximum flood and counts on spilling a super-flood into the lower ends of basins and through floodways and spillways. The commission allowed, as a factor of safety against a super-flood, a 5-ft. freeboard. The probable result of the physical and economic study recommended will be something between the two. Let it not be overlooked that added levee height means added *at the base.*

TRIBUTARY LEVEES	None	$73,000,000	+$73,000,000

Comments—The Chief of Engineers allowed for no levees on tributaries, on the ground that a study of the tributaries, with a view of flood control power development and navigation, has been ordered by Congress under the Engineer Department. Since Congress has specifically placed all tributaries below Rock Island (so far as affected by floods in the main rivers) under the jurisdiction of the Mississippi River Commission, the commission could not eliminate these items.

MAIN RIVER LEVEES ABOVE CAPE GIRARDEAU	None	$10,500,000	+$10,500,000

Comments—This 450 miles of river has been placed specifically under the commission, for flood control, and could not be ignored, in its estimate.

Item	Chief of Engineers' Estimate	Commission's Estimate	Difference
BOEUF BASIN FLOODWAY	$7,700,000	$107,000,000	+$99,300,000

Comments—The Chief of Engineers allowed nothing for damages, on two grounds: (a) That the residents and land owners will not be flooded any more frequently than they will if given no further protection; and (b) That, since this was originally flooded country, an easement for flowage is implied. The commission takes the ground that private property cannot be taken or damaged without someone having to pay for it; that the people on one side of the river cannot be supposed to suffer for the benefit of people on the other side (generally in another state) without compensation; and that no economic comparison can be made between different methods of treating floods, unless all damages (whether borne by the individual, the state, or the United States) are charged to each method. Since the people of one state must suffer for the protection of those of another state, no way could be seen except for the United States to pay the damages. The commission therefore included the following items: Flowage rights, easements, clearing, etc. $36,000,000; railway trestle or embankment $7,800,000; highway trestle or embankment $3,900,000; and drainage $4,600,000. These will account for a difference of $52,300,000. The Chief of Engineers provides for an automatic crevasse at the head, while the commission provided for a $9,000,000 spillway. The Chief of Engineers provided for a much reduced levee section at 25c. per cubic yard, while the commission provided for a full-section levee at 30c. per cubic yard. The commission's plan called for more confinement, thus reducing the area flooded, while the Chief of Engineers made more use of natural ridges in lieu of levees.

TREATMENT, EXCEPT LEVEES, BELOW OLD RIVER			
Atchafalaya Floodway	$29,900,000	$52,500,000	+$22,600,000
Bonnet Carré Spillway	8,200,000	11,500,000	+3,300,000
Caernarvon Spillway	None	10,000,000	+10,000,000

Comments—The Chief of Engineers did not allow for damages and the commission did. The commission adopted the plans of the Spillway Board which had been working for a year on treatment below Red River, while the commission had less than five months to treat the whole subject. The commission added $4,500,000 for revetment on the Atchafalaya. The Chief of Engineers eliminated the Caernarvon Spillway. The commission felt that it wanted to study that spillway before eliminating it entirely.

MISCELLANEOUS			
Dredging	None	7,000,000	+7,000,000
Surveys, investigations and overhead	1,000,000	12,000,000	+11,000,000
Auxiliary Levees	7,700,000	None	—7,700,000
Totals	$296,400,000	$775,000,000	+$478,600,000

General Comments—The commission's estimate for its comprehensive plan was an outside figure of what it would, if required to state the full project at this time, include in such an estimate. *It did not recommend its adoption*, but recommended that further studies (physical and economic) be made before determining what the ultimate plan should be. It expected such studies to reduce its figures. Meantime it recommended for adoption a lesser plan which would allow the work to go on and would have three prime advantages:

(a) It would give greatly increased protection to the delta basins;

(b) It would be a logical complete unit, in itself, if further protection were found unfeasible;

(c) It would lend itself to becoming a part of any further protection which might prove to be warranted and be undertaken.

From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

"Easing Off" Frost Boils by Snow and Ice Ramps

By H. F. Larson
County Engineer, Iron County, Crystal Falls, Mich.

FOR the past several seasons motorists have enjoyed open winter roads in the Upper Peninsula of Michigan. Snow removal is no longer a matter of guesswork and we have passed the stage of experimental work. We know that we can keep the highways open at a reasonable cost throughout the most severe winter.

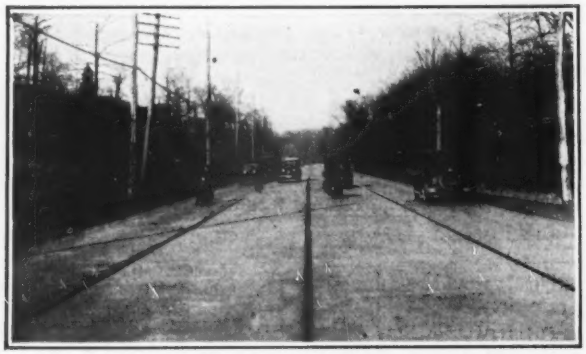
However, to maintain a winter road for high-speed traffic it is necessary that no ruts be allowed to develop and that the road surface be uniform throughout its entire width. Our winter roads under our present method of snow removal are just as safe for a forty-mile clip as in the summer time. There is, however, one condition which must be watched very closely and that is the abrupt changes in the road surface caused by heaving. Frost will penetrate a roadbed in the winter time to a depth of 6 ft. Some of these humps grow to a considerable size and our method of handling them is by easing them off by the use of snow and water. Sand or gravel is not exactly the material wanted, as it is liable to cause a soft surface whereby a car coming at a rate of thirty or forty miles per hour is likely to be thrown into the ditch. We ease off these abrupt changes with snow and then saturate them with water. This work can best be done in zero weather, as the water freezes almost instantly, making a permanent patch for the rest of the winter.

Tar Paint Traffic Lines Increase Road Capacity

By Charles MacDonald
County Engineer, Westchester County, White Plains, N. Y.

THAT the wider pavements of today are not carrying the traffic which they should has been noticeable on main arterial roads in outlying metropolitan districts. To help this situation, Westchester County, New York, has recently opened up a newly paved highway, with the four lanes for traffic clearly defined by broad bands of black paint. On Westchester Ave., White Plains, N. Y., a section 1.64 miles long, a reinforced-concrete pavement 40-ft. wide and 8 in. thick has replaced an old 18-ft. macadam roadway. The concrete was placed in four successive 10-ft. strips at an average rate of about 1,050 lin.ft. or 260 cu.yd. per day, using a machine finisher to shape the surface.

The ¾-in. radius joints between the adjacent strips were poured from pots using a tar joint filler. Following up the crew which was filling the joints, two men, using the same filler, painted a 4- to 6-in. wide black band on the pavement at these joints. The extra cost of this black band was approximately $60 per mile per joint. To instruct the motorist, signs 2½ ft. x 3 ft. have been erected at about 2,000-ft. intervals on the shoulders of the road bearing the simple legend "Drive to the Right" in large clear lettering.

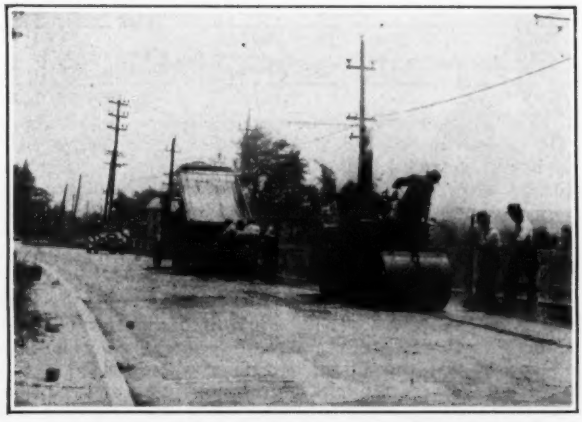


TAR PAINT-TRAFFIC LINES ON FOUR-LANE PAVEMENT

Patching Bituminous Macadam with Asphaltic Concrete in Ohio

By H. P. Chapman
Engineer-Inspector, Ohio Division of Highways

ONE of the most recent innovations in bituminous macadam maintenance in Ohio has been the use of hot mix asphaltic concrete for patches. It has been found that a much smoother surface could be obtained by this method than by using cold patch or any of the various cold mixes.



APPLYING HOT-MIX ASPHALTIC CONCRETE AS PATCH MATERIAL

The asphaltic concrete is mixed in proportions which make it a compromise between binder and seal. It is spread and compacted with a tandem roller or an iron tamper. Where the patch is of a greater depth than 2 in., it is generally applied in layers. The first layer is placed to a depth of about 2 in. and traffic allowed over it for some time, then the succeeding layer applied. On exceptionally deep patches an additional seal coat of finer mix is placed.

The asphaltic concrete costs $8 to $9 per ton at a commercial plant, and two trucks and one tandem roller will place from 35 to 50 tons per day according to the size of the patches, length of haul and type of work.

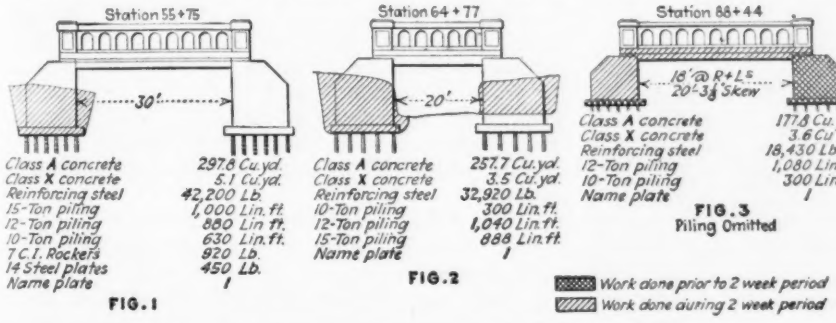
Although this method has not been used extensively, and has not had the test of time, from all appearances it seems to be one of the best yet devised. It was first used in this state by H. T. Flasher, assistant division engineer, Ohio Division of Highways.

Use of Graphic Charts to Report Bridge Construction Progress

By C. M. Hathaway
Engineer of Construction, Illinois State Division of Highways

With a large construction program widely scattered over an entire state it is necessary to keep systematic progress records in the central office; first, in order that the working schedule of each contractor may be checked; and second, in order to have first-hand information on the status of each job.

This is done by a system of weekly reports submitted by the resident engineer on each section, and while it is not particularly difficult to outline the amount of pavement laid each week or the yardage of earth grading completed, with the approximate location of each, it has proved somewhat difficult to show the actual status of construction on a bridge job by ordinary figures of yardage of concrete and pounds of reinforcing steel placed. For this reason a chart system of reporting bridge progress has been adopted by the Illinois Division of Highways, which shows at a glance the actual work accomplished on every structure. The report is made biweekly.



PROGRESS ON BRIDGE CONSTRUCTION SHOWN GRAPHICALLY

The accompanying sketch will give the reader a clear idea of the scheme. It will be noted that there is shown the total work completed to date; also the work done during the two weeks covered by the current report. For example: Fig. 1 indicates that there is completed to date practically all the excavation and pile driving in the substructure, and that during the immediately previous two weeks one abutment has been excavated and two-thirds of the piling driven. A like examination of Fig. 2 indicates that during the preceding two weeks excavation has started on the abutments, one of which has been entirely completed and the other approximately 50 per cent. On Fig. 3 it will be noted that both abutments and the floor slab have been completed. Notation is also made that piling was omitted from this structure.

The graphic sketches, for convenience to the engineer, ordinarily show the quantities in each structure and any other information which may be of value for record and identification purposes.

From this chart the construction engineer at headquarters gets an up-to-date report every two weeks and at a glance he can readily see the actual progress of the job. From the work done during the current period he can determine whether or not the contractor is working according to schedule; also, he can estimate future progress and make plans for other work which may be dependent upon the completion of that particular bridge.

Training School and Tandem Patrol Are Maintenance Innovations in New Mexico

By W. C. Davidson
Chief Engineer, New Mexico Highway Department, Santa Fe, N. M.

During the past year the New Mexico State Highway Department has put into operation two innovations in highway maintenance. If these plans are not original with the department they are at least developments beyond those employed in most states.

The first is the organization of a highway training school for maintenance men and those employed on state construction. A location in the central part of the state was selected for the school and adequate buildings provided. A competent force of instructors including a superintendent, operators of equipment, and mechanics comprises the "faculty." The course of training and instruction lasts approximately six weeks. The young men who receive training are carefully selected from a large number of applicants. The students are taught the operation and care of all highway road-maintaining and construction equipment including trucks, tractors, motor graders, graders, drags, rock crushing units, etc. A particular aptitude toward the use of any particular type of equipment is encouraged and when a student "graduates" he is expected to be proficient in the care and operation of one or more types. Students with a mechanical inclination are given special training at the hands of expert mechanics. Upon completion of the course of training a graduate is assigned to a regular maintenance patrol or state construction crew as soon as a vacancy occurs. Men old in the service are assigned to the "school" for "postgraduate" courses, and these old hands at the game find the course of instruction well worth while.

New Mexico's Highway Training School is proving its worth in better road maintenance, more competent and more careful handling of equipment, in a general atmosphere of friendly competition among patrols and pride in the care of highways which may be interpreted as "higher morale."

The second progressive plan initiated affecting maintenance operations in New Mexico is that of "tandem maintenance." New Mexico's many highways are largely of gravel or natural soil construction. The patrol system obtains in the care of these roads. Under the old plan of patrol maintenance a crew was assigned

a single combination unit of maintenance equipment, covering half the roadway on a single trip. This always resulted in a strip of loose earth, gravel and débris being left in the center of the road until the crew on its return trip completed the operation and removed the loose material. This condition resulted in partial maintenance, numerous complaints and some accidents. To offset this unsatisfactory condition "tandem maintenance" has been instituted.

In "tandem maintenance" two units of equipment are used in tandem, one following closely behind the other, the two spaced at such an interval that approaching traffic may turn out for the front machine on the right, passing the second unit on the left. The purpose of this tandem arrangement is to completely cover the road from shoulder to shoulder in one operation, thus giving maintenance to the full width of the roadbed and at the same time cleaning it of any rock, ridges of

HIGHWAY TRAINING SCHOOL CRUSHING PLANT

earth, sand or débris of any nature that might furnish a hazard to traffic. This scheme necessarily provides for the casting of the loose material from one shoulder directly across to the opposite shoulder instead of casting from both shoulders toward the center as is ordinarily done in maintenance operations.

The direct advantage of this plan is two-fold: First, it results in a flat crown roadbed which is generally admitted to be the proper design for fast-moving automobile traffic. Second, it eliminates absolutely the ridges of loose earth, rock sand and débris that are of necessity left in the center of the roadway when only one machine is in operation upon a patrol until the operator is able to make his return trip. A double covering is made on a complete round.

The equipment adapted for this type of maintenance may consist of a 5-ton tractor with an 8 ft. grader provided with right and left extensions, this unit to be followed with a motor grader equipped with a 12 ft. blade or some standard type of maintainer or drag equipment. The main idea is to arrange the two units in such a manner that they will have sufficient blade capacity to fully cover the roadbed.

This method will require the use of two maintenance units on patrols where in many instances only one is now in operation and will also make necessary a readjustment of patrols, combining some of the shorter ones and in general lengthening all patrols where the plan is not already in operation. On a 50- to 60-mile patrol, it is possible to effect a complete round trip once each week.

From Job and Office

Hints That Cut Cost and Time

Storing Snow Fence at Points Used in Michigan

By H. A. Clementsen

State Maintenance Supervisor, Alpena, Mich.

EARLY last spring after our storms were over and we were up against the need for moving and storing our snow fence we were anxious to do this at a minimum cost. We realized that taking the snow fence down, loading it on trucks, and hauling up to 10 or 15 miles would involve the expenditure of a considerable sum of money. In order to cut down this cost we conceived the idea of wiring our picket fence to the right-of-way or property fence, feeling that less damage would be sustained in doing this than in loading and unloading the fence on trucks. The fence would stand in an upright position and would be wired so that the lower portion of the fence would be approximately 6 in. off the ground to prevent rotting of the butt of the picket. This would not only be an economical way of storing fence but we would be able to store it at the most convenient points, necessitating a minimum amount of moving.

We tried this out in several counties and found that a great saving was made. We also found that this was not an economical way of storing fence unless the property fence was in good condition, as we had several sections of fence blown down which it was necessary to replace without cost to the farmer.

The objection might be raised that leaving the fence exposed all year might tend to rot out the pickets rapidly. While we have not used this method of storing long enough to definitely defy this argument, we conclude that the damage due to rotting would be less than the breakage incurred in loading and unloading the rolls of fence several times during the year.

Broom for Roughening Concrete Road Surfaces in Delaware

By C. D. Buck

Chief Engineer, Delaware State Highway Dept., Dover, Del.

ONE innovation in our construction work this year has been the requirement that the surface of all of our concrete pavements be roughened by brooming. The idea itself is not new, but I think the method we used is. Our specifications for this detail reads as follows:

> The surface of the concrete roadway shall be roughened by brooming. This will be accomplished by gently pulling a leaf rake broom over the surface, perpendicular to the edge of the pavement, from one edge to the other in such manner that the corrugations will be of uniform character, depth and width and the surface free from objectionable depressions and projections. The sides of the pavement and the joints will not be edged until after the brooming process is completed.

The desirability of roughening the surfaces of our

From Job and Office

For Contractor and Engineer

concrete roads has been brought about by the great amount of oil drippings on our principal highways which, because of this oil in wet weather, are extremely slippery.

The surface of the roadway is corrugated just after it has been given a smooth belt finish. The center strip is left smooth to allow for the painting of a longitudinal

LEAF RAKE BROOM USED ON CONCRETE ROADS

line. We soon learned that a satisfactory center line could not be painted where the surface had been roughened.

The tools used to give the 1/18 and 1/18 corrugations in the surface is a leaf rake with flexible prongs on a handle long enough for the finisher to reach at least half way across the pavement. A better job is secured when he can reach the full pavement width.

Curing Concrete Paving With Asphalt Skin Coat

DURING concrete paving with wet earth, ponding, or other usual methods, has been superseded in Los Angeles by means known as the "Hunt process," which has been used on a number of paving jobs in that city. This process, which was developed by Carl W. Hunt, chemist for McRae Products, Inc., of Los Angeles, consists in the application to the green concrete, by spraying, of a protective skin coat composed principally of lake asphalt and gilsonite. One gallon will cover from 200 to 250 sq.ft. This material, which is a patented, product, immediately forms an elastic, air-tight film over the green concrete surface preventing evaporation of the water. Ability to maintain the proper water content in the concrete during the curing period without either loss by evaporation or surface increase from wetting is one of the advantages claimed for the process.

Inasmuch as this skin coat can be quickly and easily applied immediately after concrete has been poured, protection is offered sooner than would be the case were ponding or covering with earth, hay, burlap etc., followed. Other advantages claimed for the Hunt process are elimination of hair cracking, reduction in labor, quicker cleanup on the job and reduction in total water used on the job, which latter is one of large importance in the western arid areas.

A notable instance of the use of the Hunt process curing was on the Museum Drive and in the Crane Boulevard Improvement district. The work was complicated by steep grades, difficult locations and street intersections and poor subgrade. The improvement consisted in laying 20-ft. pavements of a 6-in. thickness, reinforced integral curbing, retaining walls, cement sidewalks, sanitary sewers and water mains.

Comparing Parabolic and Circular Arcs for Pavement Crowns

By H. O. Olson
Division Engineer of Tests, Tennessee Department of Highways

STATE highway departments specify either the arc of a circle or the parabola as the shape of the crown to be used in the construction of pavements. Some highway departments specify one type on one job and the other type on the next job. For the ordinary pavement surface, however, the difference between the two curves is so small that the curves can be considered as being identical.

The accompanying table has been worked out for a 24-ft. pavement with a 3-in. crown and compares the two curves.

x in Feet	Parabola y in Inches	Circle ry in Inches	Difference in Inches
0	.000	.000	.000
1	.02083	.02083	.00000
2	.08333	.08330	.00003
3	.18750	.18743	.00007
4	.33333	.33321	.00012
5	.52083	.52065	.00018
6	.750	.74976	.00024
7	1.02083	1.02054	.00029
8	1.33333	1.33301	.00032
9	1.68750	1.68718	.00032
10	2.08333	2.08306	.00027
11	2.52083	2.52066	.00017
12	3.0	3.0	.000

The points on the parabola were computed from the parabolic formula $ay = x^2$; a is a constant and can be found as long as the x and y values for any point are known.

The points on the arc of a circle were computed from the formula $x^2 + y^2 = r^2$. It was first necessary to find r (radius). For this the formula $r = \frac{l^2 + 4h^2}{8h}$ (where l is the width of the pavement in inches and h is the crown in inches) was used. Knowing r, the value of y were computed for the different value of x. These values of y were then subtracted from r to give the values as listed in the table.

The greatest difference is only .00032 in. and the two curves can be considered as being identical.

Indiana Road Work in 1927

About 398 miles of state road were paved or resurfaced by the Indiana State Highway Commission during the fiscal year ending Sept. 30, as against 223 miles for 1926. Of this total, there were 218 miles of concrete, 72 miles of bituminous macadam or rock asphalt, and 108 miles given a surface treatment which acted as a binder to prevent dust. On Oct. 1, there were 58 miles of the 1927 work uncompleted, but 46 miles were built later, leaving only 12 miles for next spring. This gives a total of 264 miles of concrete road built in 1927. In bridge work, 99 contracts were completed for structures of more than 20 ft. span. This program has been carried out under William J. Titus, chief engineer, and A. H. Hinckle, superintendent of maintenance.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Six Bills Already In Congress Affect Road Development

Several Are Concerned with Changing Federal-Aid Status—One Would Limit Toll Bridges

OUT of the entire crop of road bills presented in this session of Congress, no more than six have particular significance for those interested in highway development, according to W. C. Markham, executive secretary of the American Association of State Highway Officials. Several of these are concerned with changing the federal-aid status so that certain roads in densely settled regions may be widened, and certain others, notably in the west, receive additional assistance. One measure seeks to regulate the construction of toll bridges, another would authorize the assignment of an engineering commission to assist the Latin American countries in highway matters. Mr. Markham estimates that hearings will be held on all these road bills soon after the holidays, probably beginning Jan. 15, although the date has not been set definitely.

Federal Aid Measures

The measures dealing with the federal-aid plan were introduced in the Senate by Mr. Oddie of Nevada and in the House by Representative Colton of Utah. Senator Oddie's bill would raise the amount of federal aid for highway construction in mountainous, swampy, and lands subject to overflow on which the average drainage and grading cost exceeds $10,000 per mile. It further provides for the extension of federal aid to such highways as may require a width greater than 18 ft., due to the density of traffic, and would increase the government's contribution for interstate highways in states whose population does not exceed ten per square mile.

A proposal to aid highway construction in Latin-American countries was contained in the President's message in which it was brought out that engineering commissions should be at least as valuable in diplomatic exchange as military or naval missions.

Representative Dowell of Iowa introduced a measure into the House authorizing the appointment, by the President, of such a commission from the engineers of the Bureau of Public Roads.

Mr. Markham pointed out that the matter of bridges as a connecting link in the highway system is becoming an important question since the roads themselves are being built so much faster. However, it is his opinion that the application by private parties for bridge permits should be more carefully regulated, particularly in the case of toll bridges. A bill has been introduced into the House by Representative Burtness of North Dakota which would prevent the construction of toll bridges over navigable streams unless it could be shown that the states affected are not in a position to construct the bridges. This measure would prevent the construction of bridges connecting interstate roads unless the highway departments of the states concerned approved the location and plans. In general, this bill also outlines a system of keeping accounts for the construction and operation of such bridges for the convenience of the states in arriving at a purchase price, when they may decide to exercise their option of buying the properties.

Dallas, Texas, Votes Bonds for 9-Year Improvement Program

The city of Dallas, Texas on Dec. 15 voted to place into immediate effect a program of city improvements that will extend over nine years and will entail the expenditure of approximately $24,000,000. Bonds will be issued yearly over a period of nine years and in no year shall the sum raised exceed $4,000,000. Tax rates will not be increased, the added indebtedness to be cared for in a slight yearly increase in property valuation. The program includes the following appropriations: Street opening and widening $5,700,000; sewer system, $1,000,000; drainage, $3,500,000; paving, $3,000,000; garbage disposal, $150,000; water system, $4,000,000; and municipal air port, $400,000.

R. L. Huntley Retires from Union Pacific System

On Dec. 31, 1927, R. L. Huntley retired from the position of chief engineer of the Union Pacific Railroad System, in accordance with the pension rules, after having held that position for nine years and having been in the Union Pacific service for 37 years. Mr. Huntley graduated from Rensselaer Polytechnic Institute in 1880 and the same year entered the engineering department of the New York Central & Hudson River Railroad. In 1886 he was location engineer for the St. Joseph & Grand Island Railway, and in August, 1888, he entered the service of the Union Pacific Railroad as an assistant engineer. In 1899 he was made principal assistant engineer, in charge of location and construction work; in 1905, acting chief engineer, and in 1906 chief engineer of the Union Pacific Railroad, while in August, 1918, he was promoted to chief engineer of the Union Pacific Railroad System.

Rival Boulder Dam Bills Introduced by Johnson and Phipps

Details of Measures Placed Before Congress by California and Colorado Senators

RIVAL bills for construction of the Boulder Canyon dam project in the Colorado River have been introduced in the U. S. Senate by Senators Hiram Johnson of California and L. E. Phipps of Colorado. The Johnson bill follows in general the Swing-Johnson bill of the last session. The Phipps bill contains some noteworthy departures.

Senator Johnson's bill (5728) authorizes the Secretary of the Interior to construct a reservoir of not less than 20 million acre-feet capacity at Black Canyon or Boulder Canyon, an all-American canal from Laguna Dam to Imperial and Coachella valleys, and a power plant to develop the energy of the reservoir overflow. To pay for construction it establishes a Colorado River dam fund, to which the treasury may loan up to $125,000,000 at 4 per cent interest, and into which all receipts are to be paid. Arrangements for repayment of the cost within 50 years after completion, with interest at 4 per cent, are to be made by the Secretary of the Interior (by contract *or otherwise*) before any work is begun; he may contract for storing and delivering domestic and irrigation water in perpetuity, and for delivering power at the switchboard for a 50-year period to public or private corporations according to the policies laid down in the Water Power Act; or he may lease all or part of the power house, or may lease the use of water for use in the lessee's own power house. The revenues contracted for, together with "other revenue accruing under the Reclamation Act," must be sufficient to cover the cost of construction, operation and maintenance.

Other Details of Bill

The reservoir is to be used first for river regulation and flood control, second for irrigation and domestic use, and, third for power; it is to be owned, controlled and operated forever by the United States, but the irrigation canal may be transferred to the district benefited after its cost is repaid, and the users may take the income of power developed upon it. The whole project is made subordinate to (1) the provisions of the Colorado River compact as drafted in 1922, which compact is approved subject to corresponding approval by *California and any three* of the other basin states;

(*Continued on p. 34*)

Reid Bill Would Vest Flood Control Power in Mississippi River Body

Representative Reid, of Illinois, has introduced into the House of Representatives a bill whereby an enlarged Mississippi River Commission would be given full power over the direction and control of the "location, construction, arrangement and maintenance of all flood-control works" on the Mississippi River and tributaries and outlets affecting its flow. The bill provides for a commission of thirteen members, five of whom would be from the Corps of Engineers, one from the Coast and Geodetic Survey and seven from civil life, all of whom would hold office for a six-year term after their appointment by the President with the consent of the Senate.

By the Reid Bill the commission would be directed to proceed at once to establish between certain designated points a system or systems of "controlled and regulated spillways, flood ways, diversion channels, storage basins and reservoirs" which would control flow at the following heights: Between Point Breeze and Fort Jackson, La., 19 ft. on the Carrollton gage and 54 ft. on the Natchez gage; between Helena, Ark., and Lake Providence, La., 48 ft. on the Lake Providence gage, 58 ft. on the gage at Arkansas City, and 54 ft. on the Helena gage; and between Cape Girardeau, Mo., and Helena, 54 ft. on the Helena gage, 43 ft. on the Memphis gage and 54 ft. on the gage at Cairo.

To carry out the program the commission would be empowered to utilize the engineering services of those government departments relating to the "study, development, or control of rivers, and subjects relating thereto."

Many Gas Holder Explosion Claims Settled

"Square dealing without quibbling" has been the policy adopted by the Equitable Gas Company in settlement of claims resulting from the explosion Nov. 14 of a gas holder at Pittsburgh. (See *Engineering News-Record*, Nov. 17, p. 813.) The policy, according to the announcement of A. W. Robertson, president of the company, includes immediate payment of all hospital bills of those injured, repairs to property damage suffered by eight hundred home owners and tenants, and an offer to meet claims for personal injuries. The question of meeting damages that may be claimed by large corporations can wait until the question of liability has been determined. However, with regard to individual injuries the company has decided to proceed on the aforementioned basis rather than upon legal liability.

In line with this principle, the Equitable Gas Company immediately after the accident sent 16 two-man teams into the field to inventory damage to property without fixing values for restoration purposes. Representatives were sent to all hospitals and to the Red Cross and there gathered such information as possible to secure a complete record of personal injuries. They also secured from a contractor estimates of costs of restoration. These data were classified and filed in the general offices of the company so that it was possible to begin settling claims within a week after the accident.

Claims for personal injuries and property damage are made at the general office of the company where a force of six men is assigned to the work of adjustment. Up to and including Dec. 6, 201 claims had been settled. Those being adjusted now are minor ones, and those wherein the claimant is not able to restore his damaged property.

Title to Muscle Shoals Power Vested in Federal Government

Full title to the power properties at Muscle Shoals on the Tennessee River in Alabama is vested in the federal government according to an opinion of the assistant attorney general, B. M. Parmeter, made public by the attorney general on Dec. 29 "without signature and without comment." Mr. Parmeter said in his opinion "This is not a case where the government has entered upon the business of generating power for commercial use. It is a case where the government, under its constitutional power, has entered upon the prosecution of a work of national concern, relating to national defense and the improvement of navigation, in which a surplus product is created which can be disposed of in meeting the operating and maintenance costs of the plant and to afford an opportunity for recoupment of a portion of its vast expenditure in constructing them. That the government has a right to do this is beyond question."

Terminal Port Change Adds Cost to Hudson Bay R.R.

As a result of the change in the terminal port of the Hudson Bay Railway, the cost of constructing the road will be increased by more than $5,000,000 and the line will not be in operation until one year later, are facts outlined in the annual report of the deputy minister of Railways and Canals of Canada, Major Graham Bell. The surveyed line to Churchill, Major Bell says, leaves the present Hudson Bay Railway location at Mile 356.8 and runs north from Township 28, range 21, east of the principal meridian, to Township 112, range 20. The last 28 miles parallel the Churchill River.

"The line to Churchill from Mile 356.8 would be 154 miles long as against 65 miles to Nelson, and the cost to Churchill would be $7,543,000 as compared with $2,458,000 to Nelson" reports Major Bell. "The foregoing estimates include half a million for railway terminals at either place. The engineers believe the line to Churchill could be completed in two working seasons or by December, 1929, and the line to Nelson by December, 1928."

Bombing Concrete Bridge By Air Service Yields Valuable Military Data

Valuable information on the destructive effect of bombs dropped from an airplane on reinforced-concrete structures was secured in the destruction by that method last week of the Pee Dee River bridge in North Carolina by the Army Air Corps. The Air Corps was designated to destroy the bridge when the State Highway Commission asked the War Department if the opportunity to destroy it would afford the department means of securing data of military value.

The bridge was constructed only a few years ago but modern demands for the creation of a source of power made it necessary to erect a dam on the Pee Dee River south of this bridge at a height which would have resulted in the submergence of the bridge in the lake thus created. This necessitated the building of another bridge north of the first one, and at a greater height in order that traffic across the newly made lake might not be interrupted. Loading tests were made by the State Highway Department prior to the destruction of the bridge. The bridge was 20 ft. wide and approximately 1,000 ft. long consisting of three channel spans and seven approach spans on either side.

Flying at a height of 6,000 to 8,000 ft., the altitude necessary for the bombing, first 300-lb., then 600-lb. bombs were dropped to determine what the injury would be. The 300-lb. bomb offered no serious menace to construction of this type. Use of 600-lb. bombs indicated that though direct hits did some damage, it would not result in the demolition of the structure.

The attack of the bridge with 1100-lb. missiles resulted in nearly 25 per cent direct hits, and quick reduction of that part of the bridge turned over to the Army Air Corps for experimental purposes. The first bomb which struck the bridge destroyed two approach spans of a length of 80 ft., and the second demolished two more approach spans. The last two hits, striking close to the pier, put this out of commission.

Texas Water-Works Short School to Meet in Houston

Houston will be the meeting place for the tenth annual water-works short school held under the auspices of the Texas State Board of Health, Jan. 23-27. Among the speakers from outside of Texas will be George W. Fuller, consulting engineer, New York City; August V. Graf, of the water-works of St. Louis, Mo.; M. Z. Bair, state sanitary engineer, Little Rock, Ark.; Frank Bachman, sanitary engineer, the Dorr Co., New York City; Arthur Brown, sanitary engineer, Chicago, and L. H. Enslow, research engineer, Chlorine Institute, New York City. Dr. J. C. Anderson, state health officer, Austin, Tex., is chairman of the program committee.

Missouri River Drainage Is Subject of Conference

The first session of the Missouri River Drainage Basin Technical Conference was held at Omaha Dec. 22 and 23 at which time a resolution was adopted urging the creation of a federal fact-finding body for the comprehensive survey and study of data upon which might rest a policy or plan for flood control and conservation of water resources. The resolution also called upon Congress to provide for the improvement of the Missouri River for navigation "as a necessary and indispensable part of the Mississippi Valley Waterways."

The conference was attended by technical educational groups, state engineering department representatives, irrigation and drainage district groups and city and county engineering groups in Montana, North and South Dakota, Wyoming, Colorado, Nebraska, Iowa, Kansas and Missouri—all of the states within the Missouri River drainage basin.

The conference voted to gather, correlate and distribute, where it could best be used, existing information which might form a basis for intelligent solution of the flood-control and navigation problems of the Missouri. Officers were elected as follows: President, T. A. Leisen, general manager of the Omaha Metropolitan Utilities District; Frank M. Dawson, professor of hydraulics, University of Kansas, vice-president; and Clark E. Mickey, head of the department of civil engineering, University of Nebraska, secretary.

Papers presented at the conference included the reading of Secretary Hoover's address on a "National Policy for the Development of Water Resources" read before the Columbia River Basin League; "A Plan or Policy for the Development of the Missouri River and Its Principal Tributaries," Prof. Clark E. Mickey; "River Hydraulics," Prof. F. M. Dawson; "Flood Control," E. J. McCaustland, dean, College of Engineering, University of Missouri; "The Relation of State and Federal Survey to River Control," Dr. Geo. E. Condra, director, Conservation and Survey Division, University of Nebraska; and "The Tragedy of Inadequate Water for Agricultural Development," Prof. J. C. Russell, professor of agronomy, Agricultural Experiment Station, University of Nebraska.

Colorado U. to Hold Second Highway Conference

The second annual highway conference will be held at the University of Colorado in Boulder on Jan. 19 and 20, 1928. Representatives of the U. S. Bureau of Public Roads, the state highway departments of Wyoming, New Mexico and Colorado, the Colorado State Association of County Commissioners, The Colorado Municipal League, and others interested in the construction of good highways will participate. The participation of Wyoming and New Mexico means that the Highway meeting to be held at the university assumes an interstate aspect inasmuch as all states in District No. 3 of the U. S. Bureau of Public Roads are represented.

Rival Boulder Dam Bills

(*Continued from p. 32*)

(2) the terms of any compact that may be arrived at by Arizona, California and Nevada for "the equitable division of the benefits, including power, arising from the use of water accruing to said states." If the last mentioned compact is not entered into by June 1, 1928, then 15 per cent of the power available at the dam is to be reserved for sale to each of these states, for a period of six months.

Two important additional provisions are made in the Johnson Bill. First, that all public lands adapted to irrigation by the waters of the reservoir be withdrawn from entry and later (presumably after construction of irrigation works at the expense of the fund) be opened for entry in 160-acre tracts; and, second, that the Secretary investigate the feasibility of irrigation, power and other water use projects in Arizona, Nevada, New Mexico, Utah, Colorado and Wyoming, for the formulation of "a comprehensive scheme of headwater control and the improvement and utilization of the water of the Colorado River and its tributaries." For the latter purpose, an appropriation of $250,000 is authorized.

The Phipps bill (5274), while also providing for construction of a 20,000,000-acre-ft. reservoir, leaves the location of the dam to the Secretary of the Interior. It does not mention the all-American canal, but authorizes him to construct "suitable irrigation and other works" for irrigation and domestic supply of the Imperial and Coachella valleys if he considers them necessary. It establishes a Colorado River dam fund like the Johnson bill, with similar repayment provisions, but limits the treasury advances to this fund to $90,000,000. Licenses for use of power flow from the reservoir are to be granted by the Federal Power Commission, the charges being fixed by the Secretary of the Interior. The dam and "incidental works" are forever to be owned and operated by the United States. However, no work may be begun until *all seven basin states* have approved the Colorado River compact of 1922. Any agreement between California, Nevada and Arizona concerning the division of water and power under the compact (regardless of when arrived at) is to be controlling.

After making provisions for withdrawal of irrigable land from entry, the Phipps bill directs an investigation of irrigation and power possibilities in the four upper basin states only. Finally it suspends the issue of licenses by the Federal Power Commission for any navigation or power improvement on the Colorado or its tributaries until approval of the compact.

Geological Survey May Get Inland Geodetic Work

Transfer of inland geodetic work from the Coast and Geodetic Survey to the U. S. Geological Survey is recommended in a joint letter which has been sent to Congress by the Secretary of Commerce and the Secretary of the Interior. This is in line with the views expressed by Secretaries Hoover and Work at the reorganization hearings. Legislation to put the recommendation of the secretaries into effect has been introduced in the Senate by Mr. Nye as S. 1913 and in the House by Mr. Sinnott as H. R. 7480.

The change will interfere in no way with the work of the Coast and Geodetic Survey pertaining to the coast line or submarine work and will not transfer any of that bureau's commissioned officers. The inland geodetic work, however, would be transferred as the Geological Survey can do the primary, secondary and tertiary work much more effectively than it can be divided between the two agents. If the transfer is approved by Congress it will mean the shifting of appropriations in excess of $100,000. In the past much of the geodetic work, while of ultimate value to topographic surveys, has not contributed to the work in progress. Under the new arrangements it can be arranged so that the primary work can be followed immediately by the secondary work by the same engineer, with the result that it can be fitted to the immediate needs of topographic mapping.

Brooklyn Polytechnic Raises Degree Standards

The Polytechnic Institute of Brooklyn, through its faculty and corporation, has voted to raise the standard of its engineering degrees by increasing the requirements for such degrees. Heretofore the degree of civil, electrical or mechanical engineer has been granted upon the successful completion of four years of prescribed work. The degree of chemical engineer has been granted upon the completion of five years work. Under the new plan, which becomes operative with the class entering in the fall of 1928 the degrees of Bachelor of Civil, Electrical and Mechanical Engineering will be granted at the end of the regular four years; and Bachelor of Chemical Engineering upon the end of a five-year course. Upon the completion of one year of actual experience in the engineering field and twelve semester hours of graduate evening work at the Institute, the degree of Civil, Electrical, Mechanical or Chemical Engineer will be granted. The engineering degree may also be gained by three years of approved engineering experience and the submission of a thesis. The granting of engineering degrees for men of the evening courses will be governed by similar requirements as those of the day courses, though here the engineering experience may be concurrent.

Engineers for Queens Borough Sewer Investigation Named

Announcements have been made of engineers engaged by both the prosecution and the defense in the petition to the governor of New York for the removal of the president of Queens Borough, New York City, for alleged irregularities in extensive sewer construction work. Emory R. Buckner, special counsel to Supreme Court Justice Townsend Scudder, appointed to conduct the investigation for the governor, announces the selection of Allen Hazen, of Hazen & Whipple, New York City, as head of Mr. Buckner's engineering staff, and choice of Harrison P. Eddy, of Metcalf & Eddy, Boston, as associate in the investigation. Borough President Maurice E. Connolly has engaged Prof. William H. Burr, New York City, and Edwin J. Fort, the latter for many years chief engineer of the Bureau of Sewers of Brooklyn Borough, New York City, then for a time city manager of Niagara Falls, N. Y. Before entering into partnership with the late Leonard Metcalf, Mr. Eddy was for many years superintendent of sewers of Worcester, Mass. Feb. 1 has been set as the date for beginning the hearings.

Delaware & Hudson Merger Plans Fail of Approval

Plans of the Delaware & Hudson Co. for the lease of the Buffalo, Rochester & Pittsburgh Railroad for a term of 999 years have not met with the approval of the Interstate Commerce Commission. The Delaware & Hudson Co. proposed to connect its own line with that of the Buffalo, Rochester & Pittsburgh by means of a trackage rights agreement over the Pennsylvania Railroad between Buttonwood and Dubois, Pa.

The commission does not approve of this arrangement on the ground that the arrangement proposed is not permanent enough, the trackage agreement with the Pennsylvania R.R. being for a relatively short term of years, and also because the combination might be detrimental to a more comprehensive plan of railroad consolidation in the East.

Grade Crossing Accident Victim Liable for Negligence

In the Circuit Court of Appeals for the Eighth Circuit it has been held that a traveler approaching a railroad crossing must look and listen at places and at times where and when his senses will give notice of approaching trains, and if he fails so to do, and is injured on the crossing by a train, such failure is negligence and his right of recovery for injuries received is not allowed. The case was one wherein action was brought to recover damages for personal injuries to two plaintiffs inflicted at a grade crossing at the Pikeview Coal Mine a few miles north of Colorado Springs on the line of the Atchison, Topeka & Santa Fe Railway Company. The plaintiffs were in a motor truck loaded with coal which had successfully crossed four switch tracks but which was hit and dragged several hundred feet by a train going at a speed variously estimated at 40 to 60 miles an hour.

This case is interesting in that it is the first in which the court has referred to the decision of the Supreme Court delivered Oct. 31, 1927 in the case of the B. & O. Railroad Company against Goodman. (See *Engineering News-Record*, Nov. 10, 1927, p. 774).

Washington Notes

THE report of the International Joint Commission that investigated the St. Lawrence waterway project would be accepted by Congress under a resolution presented by Representative Mapes of Michigan. To put the recommendations in this report into effect, it is proposed to create an International Board of Engineers who would work out detailed plans for the construction and operation of the waterway. Attention would also be paid to the matter of ascertaining the maximum efficiency of water power for such a waterway. It is further recommended that this waterway be not less than thirty feet deep.

An appropriation of $100,000 is recommended to defray the expenses of this International Board of Engineers the money to be paid out of the Treasury on warrants drawn by the President. The expenses of the Canadian section would be paid, of course, by their own government.

THE growing interest in the development of power at dams intended primarily for navigation purposes is being reflected in the planning of new structures of this type. In the future all such dams probably will be constructed so as to facilitate the development of any incidental power that may be available.

This situation is reflected on the Kanawha River where a new navigation dam is being considered to replace existing dams Nos. 2, 3 and 5. A hearing before the district engineers is to be held at Charleston, Jan. 12, to consider the power plans of the new Kanawha Power Company and of the West Virginia Power Company. Both of these companies have applied for the power rights at the proposed dam.

PERMISSION to span the Ohio River at Ashland, Kentucky, is sought in a measure introduced into Congress by Representative Vinson of Kentucky, in behalf of the Ashland Bridge Company. Under the terms of the bill, the company would be empowered to charge a toll for transit over the bridge. Provision is made for the acquisition of the property at the option of either the state of Ohio or the state of Kentucky.

Railway 85 Miles Long to Be Built to Manitoba Mines

In accordance with an agreement entered into by the Canadian Government with the Whitney interests of New York who have taken over the Flin Flon copper mine in Northern Manitoba, a railway 85 miles in length is to be built to the property, from a point on the Hudson Bay Railway near the Pas. The Canadian National Railways have issued an official announcement that the contracts for the construction for the line have been let to the Dominion Construction Company, and The Tomlinson Construction Company of Toronto and Winnipeg. These companies will soon begin the establishment of a construction camp at the mine, and within four weeks upwards of 500 men will be engaged on the work, which it is hoped will be completed before the end of next year. Under the agreement entered into by the Dominion Government the Whitney interests undertake to build a smelter capable of treating 3,000 tons of ore per day and to establish a large water power development with an ultimate capacity of 270,000 hp. These works will involve an initial expenditure of $18,000,000.

V.M.I. to Hold Highway Conference

The Virginia Military Institute in cooperation with the U. S. Bureau of Public Roads, the Virginia State Highway Commission and the board of supervisors of Rockbridge County, will hold a highway conference at the Institute February 3 and 4. The first day's sessions will be devoted entirely to county highway problems and papers will be presented on "The County Unit System in Virginia," "Methods for Locating the County Highway System," and "Proper Marking of Important County Highways." The session on Feb. 4 will be devoted to discussions on "Selection and Use of Local Materials for Low-Cost Roads," "Types, Uses and Care of Road Equipment," "The Right-of-Way Problem," "Surface Treating of Low-Cost Roads" and "Co-operation Between the State and Counties."

Sewage Association is Organized in Central States

The Central States Sewage-Works Association was organized in Chicago on Dec. 17. Its first annual meeting will be held in Milwaukee at a date yet to be determined. Statistics presented at the meeting showed that there are 134 sewage-works in Illinois, 100 in Wisconsin and 37 in Indiana. Any person interested in such works is eligible for membership on payment of the annual dues of $5. President, Robert Cramer, Milwaukee, Wis.; vice-presidents, L. S. Finch and F. W. Mohlman; treasurer, L. F. Warrick; secretary, G. H. Radebaugh, Urbana, Ill.

Personal Notes

A. F. STOTLER, district engineer, lines west of Ellensburg, has been appointed assistant chief engineer and engineer, maintenance-of-way, lines west of Paradise, of the Northern Pacific Railway Company, with headquarters at Seattle, Wash., vice A. R. COOK, who will be retired under the pension rules after twenty-six years' service. G. I. HAYWARD, district engineer, lines between Paradise and Ellensburg, will succeed Mr. Stotler and H. M. TREMAINE, assistant engineer of construction, will succeed Mr. Hayward.

B. J. T. JEUP, who has been on leave of absence as chief engineer of the Indianapolis Water Company for the past year because of ill health, has been made consulting engineer and his position has been filled by W. C. MABEE, who has been acting chief engineer in the absence of Mr. Jeup. Mr. Mabee has been actively connected with the engineering department of the Indianapolis Water Company for more than 25 years. He went to Indianapolis to take charge of the first slow sand water filter, built in 1902. Since that time he has been successively constructing engineer, designing engineer, assistant chief engineer and acting chief engineer.

REUBEN W. SMITH has joined the staff of the National Lumber Manufacturers Association as field engineer. He has been temporarily attached to the western division office. For two years Mr. Smith was professor of wood utilization at the New York State College of Forestry at Syracuse. He also spent a year at the Forest Products Laboratory at Madison, Wis. Mr. Smith is a graduate of the forestry school of the University of California and did graduate work at the University of Wisconsin.

W. A. JAMES, assistant chief engineer of the Canadian Pacific Railway, with headquarters in Winnipeg, has retired from active service after completing 30 years with the company. He joined the C.P.R. in 1898 on the construction work of the Columbia and Western Railway. His career, which has included some of the most important engineering propositions in Canada, has been one of steady progress, and his ability won for him posts of increasing responsibility.

H. C. MANN, assistant chief engineer of the Union Pacific Railroad System, has been appointed chief engineer, succeeding R. L. Huntley, who has been retired under the pension rules.

MOSES BURPEE, chief engineer of the Bangor & Aroostook Railroad, has retired from that position at his request and has been made consulting engineer to the road. His headquarters have been at Houlton, Me. P. C. NEWBEGIN, maintenance engineer at Houlton, has been appointed chief engineer.

Engineering Societies

Calendar

Annual Meetings

INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS, Chicago, Ill.; Annual Conference, Detroit, Mich., Jan. 9-10, 1928.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington, D. C.; Annual Convention, Cleveland, Ohio, Jan. 9-14, 1928.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 18-20, 1928.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; Annual Convention, West Baden, Ind., Jan. 23-27, 1928.

NATIONAL ASSOCIATION OF BUILDERS' EXCHANGES, Washington, D. C.; Annual meeting, Miami, Fla., Feb. 6-9, 1928.

ENGINEERING INSTITUTE OF CANADA, Montreal; Annual Meeting, Monday, Feb. 14-16, 1928.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Convention, Philadelphia, Feb. 28, 29 and March 1, 1928.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill.; Annual Convention, Chicago, March 6-8.

THE NEW YORK STATE SOCIETY OF PROFESSIONAL ENGINEERS AND LAND SURVEYORS will hold a special meeting at the United Engineering Societies Building, 29 West 39th St., New York City, on Jan. 17, 1928, at 8 p.m. A discussion on the forming of additional county chapters, and engineering and surveying fees will be discussed and city and state legislative action will be reported upon.

Obituary

DENNIS MADDEN, general superintendent of MacArthur Brothers Co., died Oct. 20 at his home in LaGrange, Ill. He was a well-known railroad construction superintendent.

JESSE D. SMITH, 56 years old, general manager and treasurer of the Pan-American Bridge Company of Newcastle, Ind., died recently at his home after a brief illness. He was one of the first city councilmen in Newcastle.

HENRY T. WINCHESTER, who had had a long and varied career as a construction engineer and who was, for a number of years, identified with Stone & Webster, was killed in a grade crossing accident at Detroit, Dec. 30. Mr. Winchester was born in Boston in 1876, and was a graduate of the Massachusetts Institute of Technology. He was educated as an electrical engineer but turned to construction engineering early in his professional life. At the outbreak of the World War Mr. Winchester was placed in charge of the construction of Camp Custer, later going to Hog Island for Stone & Webster as construction engineer. In 1919 he returned to Detroit as a consulting engineer and had done also considerable work in St. Louis. At the time of his death he was vice-president of the Apex Coal Company and had made his home in Ann Arbor since last year.

ALLEN N. SPOONER, head of the engineering firm of New York which bears his name, and former dock commissioner of New York City, died at St. Luke's hospital, New York City, Jan. 1 following an operation. He was 63 years old. Mr. Spooner was graduated from the school of mines of Columbia College in 1886 with a civil engineering degree. For a year following his graduation he was employed in the maintenance-of-way department of the Pennsylvania Railroad, following which he entered the employ of the Department of Docks, New York City, as a hydrographer. He was then promoted to the position of assistant engineer in charge of bulkhead wall construction along the East River, and later to assistant engineer in general charge of dock department work on the East and Harlem rivers. He was made commissioner of docks during the term of office of Mayor Gaynor. His consulting practice was concerned chiefly in the design of waterfront improvements. He was elected a member of the American Society of Civil Engineers in 1900.

GEORGE A. CARPENTER, city engineer of Pawtucket, R. I., and president of the New England Water Works Association, died recently after an illness of about two months. He was 64 years of age. Mr. Carpenter was born at Pawtucket March 4, 1864, and began his professional career in the office of D. Lawrence Wilkinson, civil engineer of that city. In 1884-1885 he was engaged on surveys for the storage reservoir at Pawtucket and later on pumping station construction. General engineering studies occupied his time from 1883 to 1888, in which latter year he was made engineer of the sewer commission of Central Falls, R. I. Leaving Central Falls in 1891 he was appointed city engineer of Pawtucket and held this position up to the time of his death. Mr. Carpenter was prominent in the water-works field, having been elected to membership in the New England Water Works Association in 1910. In 1921 he was made vice-president and in September, 1927, he was made president, succeeding Frank E. Windsor. Mr. Carpenter was a member of the American Society of Civil Engineers, the Boston Society of Civil Engineers, the Providence Engineering Society and the American Society for Municipal Improvements. As the result of his death Arthur D. Weston, vice-president of the New England Water Works Association and principal assistant engineer of the Massachusetts Department of Public Health in charge of water supply, will serve as president.

Road Building Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

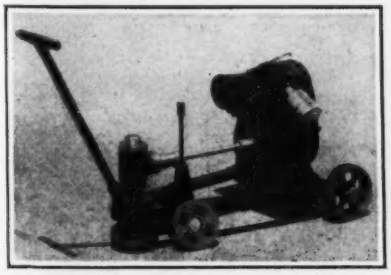
Exhibit Reservations Coming In For A.G.C. Meeting

In connection with the meting of the Associated General Contractors of America in the West Baden Springs Hotel, West Baden, Ind., January 23-27, some 70 equipment and material companies or allied trade groups have completed arrangements to exhibit, according to a recent announcement. It is said that practically all the materials and supplies and every method and process used throughout the construction field, including building, highway, public works and railroad construction, will be shown. According to the announcement, also, arrangements have been completed for the use of a half acre of outdoor display area for the placing and demonstration of large and bulky construction equipment and machinery. It is stated that more than half of this outdoor space has already been placed under reservation by exhibitors.

New Developments

Machine Smooths Uneven Pavement Surfaces

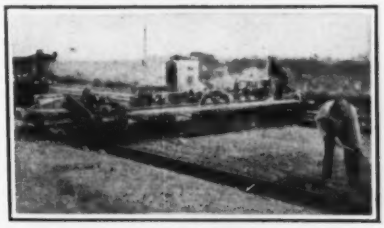
A highway surfacing machine operated by an air-cooled gasoline engine, is a new product of the Concrete Surfacing Machinery Co., Cincinnati, Ohio.



The machine is designed for use in cutting down uneven expansion joints, repaired spots and other corrugations in highway pavements. The cutting tool is connected to the power unit by a flexible coupling operating hardened bevel gears running in oil. All shafts and gears are carried on Timken roller bearings and the machine is completely of steel construction. This highway surfacer is 3½ ft. long, weighs approximately 240 lb. and is operated by one man. Two iron wheels at the rear end of the chassis and a swivel caster in front provide a means for easily hauling the machine from place to place. Raising the swivel caster lowers the cutter edge and brings it in contact with the road surface, where the cutters, 24 to a set, each ⅛ in. wide and 2 in. in diameter, made of high grade steel, rotate at a speed of 1,200 r.p.m., thus making a contact 1,600,000 times a minute. Two cutting plates mounted with cutters are supplied with each machine. It is claimed that the machine is equally effective on old and new pavements.

A New Finish Grading Machine

After tests covering two consecutive seasons, A. W. French & Company, Chicago, is offering a new machine known as a finish-grader. This new machine is designed to cut the finish



or fine grade after the highway forms have been set. Running on the forms, it cuts the grade true to elevation and crown and is self-propelling both forward and reverse. It delivers the surplus dirt to a pile on the outside of the form.

Bottom Dump Truck Body for Wet Concrete Haulage

Designed expressly to facilitate the handling of wet concrete from central mixing plants, a body has recently been made available by the Hug Company, Highland, Ill., with several notable features. In the first place, it is a rear bottom-dump design and the wet batch is remixed as it leaves the body. Also because of this bottom dump feature the body clears itself of all the wet batch material. The entire operation of the body is controlled from the driver's seat. As the hydraulic hoist raises the body,

the upper shell of the body is elevated by toggle arms, thereby separating the shell from the bottom part or bed. The new body is equipped with rigid cross members, and the falling of the wet batch through these rigid members as the body is raised, causes the remixing action. The illustration shows a body with a 2-yd. capacity for wet concrete mounted on the company's model HH chassis.

New Type of Service Inaugurated For Repairing Pavements

The repair of plumbing and utility cuts in pavement, is a new service recently offered by the Asphalt Brick Service Company, St. Louis, Missouri. According to the company its plan is to

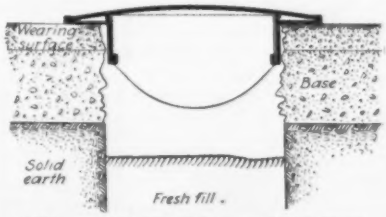


FIG. 1—COVER FOR PROTECTING OPEN TRENCH

take the place of the old method of tamping the earth and covering the top fill with brick and sand, pending the settling of the earth, then refilling and repaving each time the fill develops into a rut. It is said that the new plan has been tried out in St. Louis and is a success. The repaving work is handled by the company's organization. Under the supervision of the city inspector the ditch will be filled and well tamped as usual to within 14 in. of the pavement level. For the purpose of protecting the opening at night, the company has a specially designed metal trench cover, reinforced to stand the impact of a 10 ton truck. In Fig. 1 the trench cover

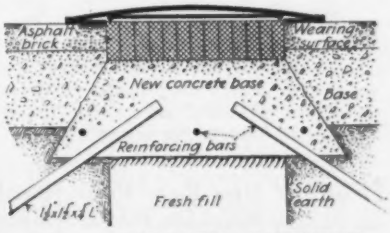


FIG. 2—COMPLETED PAVEMENT CUT REPAIR

is shown in place for protecting the solid material on each side of the trench, and preventing, by means of a hinged door below the street level, a shifting of the cover from a fixed position.

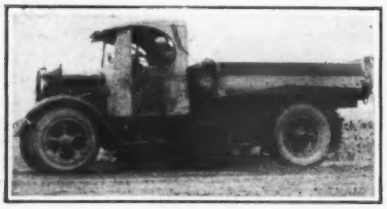
The permanent repair is shown in Fig. 2. Both sides and two ends of the trench are trimmed back to form a shoulder for the new concrete to rest upon. Angle bars are driven through the shoulder to interlace with reinforcing bars running in both directions. A quick setting concrete is then used to fill the trench to within 4 in. of the pav-

ing level forming a slab upon which the asphalt bricks can be placed. The trench cover is replaced with the doors folded, and remains for a period of 24 hours or until the concrete slab is properly set.

Arrangements have been made with a reliable insurance carrier to issue a liability policy which will cover any individual, firm or corporation for whom the Asphalt Brick Service Company will do this work.

Motor Truck Scraper Improved By Hydraulic Control

A scraper which has been manufactured for a number of years by the Root Spring Scraper Company, Kalamazoo, Mich., for attachment to motor trucks in gravel and earth road maintenance service, has been improved by the addition of hydraulic control. There are a number of objections to a hand-operated scraper, according to the company. It is difficult to attach to a truck because

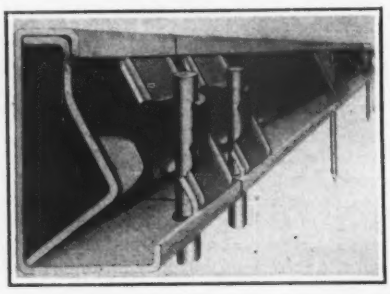


the necessary raising and lowering device must be built into the cab; there is difficulty in applying the scraper to the road with enough pressure to cut out chatter bumps; and such a scraper is slow acting because operation is through worm gears.

The company has employed the hydraulic pump used on dump trucks to generate the pressure necessary to operate its scraper. The ordinary pressure required is about 500 lb. for a 3 ton truck. The pump and body dump installation is not changed in any way, a section of the pipe running from the pump to the dump cylinder being cut out and a three-way stop-cock installed. In one position the dump body operates, and in the other pressure is applied to the cylinder to operate the scraper.

Design of New Road Form Based on Heavy Machine Requirements

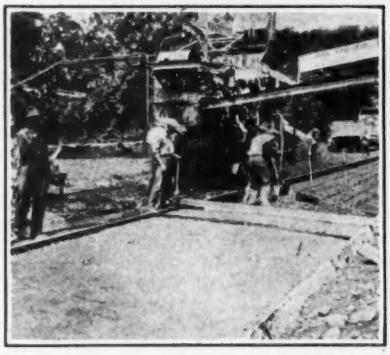
A new road form has been designed by the Heltzel Steel Form & Iron Company, Warren, Ohio, to meet the requirements of the heavy machinery of today. The new form is made of $\frac{7}{16}$ in. steel plate with double reinforcing flanges and a 6 in. base. Massive steel stake pockets are welded to the two rail flanges to take 1 in. round steel stakes. An angular shaped steel joint lock made of $\frac{1}{4}$ in. steel plate is used. This lock wedges between the stakes and the face of the rail with one leg of the lock against the intersection of the face and top of the rail, the other leg against the intersection of the face and base of the rail. Two wedge shaped swells pressed into the stake lock, wedge one against each stake, making what is claimed to be an absolutely positive locking arrangement. A larger swell pressed into the stake lock serves as a releasing lug which, when tapped with a sledge, unlocks the form.



An additional feature of this new locking arrangement is that it not only locks the form, but automatically aligns the rail ends. The form is a complete unit with the stake lock in one end of the rail, there being no separate parts excepting the two stakes. To set the form, the rail ends are simply butted together, the lock joint is placed in position and the stakes driven. One tap with the sledge is said to lock the forms and align the rails.

New Concrete Pavement Has Removable Top Service

The outstanding feature of a new development in concrete paving brought out by the Sheet Concrete Pavement Corp. of America, New York City, is the incorporation of a splitting plane in the slab between the top and the base



LOWER COURSE AND SEPARATING FABRIC OF TWO COURSE SLAB

course. This splitting plane allows, when splitting pressure is applied, the removal of the top course for replacement and repairs, but against all other stresses the pavement is claimed to act as an integral slab.

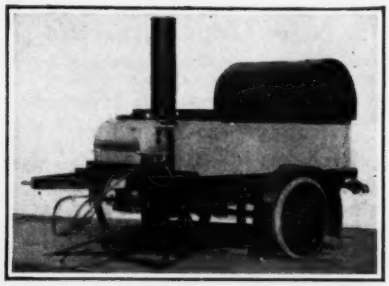
The base course is laid with a dry mix using a minimum of cement while extra cement is used in the surface. It is necessary that the base course be laid of a dry mix and tamped or rolled into place in order that it be in proper shape to receive the top course without displacement. After laying the base course, a fabric pervious to mortar but impervious to coarse aggregate is tamped into the base course, the mortar coming through and providing practically full adhesion with the top course. The top course is then laid of a rich mixture and fine aggregate which allows ease of finishing and provides a dense, strong, nonporous surface without a mortar surface coat.

Tests carried on by H. Eltinge Breed, consulting engineer, New York City, on cylinders and beams are said to show that against all stresses other than splitting pressures, such construction acts as a unit. Tests on beams so heavily reinforced as to cause them to fail in shear at the abutments have shown no weakness along the line of the cleavage plane. It is claimed for this pavement that it gives a superior concrete pavement and has all of the advantages of other removable surface types, but at the same time the top course increases materially the strength of the pavement.

The base course is recommended to be laid of approx. a 1:2½:5 mixture and the top course of one cement, 1½ sand and 2 of traprock or other good aggregate from ¼ in. to ⅜ in. in size.

Tar and Asphalt Melting Kettle for Maintenance Work

A tar and asphalt melting kettle of 300 gal. capacity suitable for road maintenance work and particularly desirable



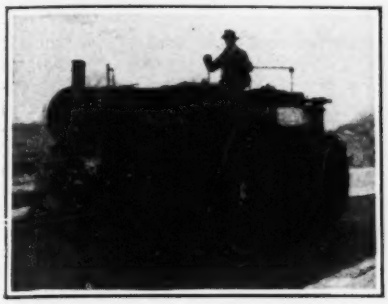
for state highway work inasmuch as it is mounted on a high-speed trailer, has recently been developed by Littleford Bros., Cincinnati, Ohio. The new piece of equipment is known as the No. 78-OB oil burning "trail-o-heater." The oil burning feature is claimed to make it a very fast and efficient piece of equipment. Heat is supplied by two oil burners aided by special insulation in the bottom of the combustion chamber. A draw-off cock is located on each side of the heater at the rear end. A warming hood is provided at the top under which barrels may be drained. The wheels are equipped with Timken roller bearings and axles are cushioned with springs which absorb all road shocks.

Tandem Roller in 10-Ton Size

The new 10-ton heavy-duty tandem motor roller recently announced by the Galion Iron Works & Mfg. Co., Galion, Ohio, to supplement its other motor tandems which are now made in 5, 6, 7, 8 and 9-ton sizes, may be both gasoline engine and steam operated.

It is stated that the new roller is a direct result of the demand for more compression on asphalt and for a motor roller instead of the steam type.

The new roller is powered by a Hercules Model G motor. The power steer-



ing is operated by the same motor; the machine has a three section steering roll. By means of a special transmission, it is possible to reverse instantly and smoothly without gear shift, so that the operation of the machine is both quick and smooth.

Screed Designed for Half Width Pavement Construction

A new screed known as type "F," adjustable for both 9 and 10 ft. widths, is a new product of the Lakewood Engineering Company, Cleveland, Ohio. It is designed for half-width pavement construction. A feature of the machine is its ability to finish widened curves without the necessity for using false forms.

The screed member is of wood, faced with metal, 12 in. wide at the bottom, with provision for tilting, driven at

speeds of 35 to 40 strokes per minute. The power unit is a two-cylinder radiator-cooled Novo 6-hp. engine. A sliding-gear fully-inclosed transmission, running in oil, is used in connection with chain drive to all four wheels. The belt is 14 in. wide, single ply, specially prepared rubberized canvas, driven at 35 to 40 strokes per minute. The weight of the machine on the forms is 4,250 lb. without belt.

Material Body for Mounting on Maintenance Grader

A new development recently announced by Anthony Co., Inc., Streator, Ill., consists of a stock model body of the Ford type which can be mounted on a Fordson-Wehr one-man grader. Such a piece of equipment has grown from the demand of highway officials for a machine that will more nearly meet their maintenance requirements. The patrol graders often encounter chuck holes and unless a truck carrying sand and gravel is accompanying it the holes would be passed over. This new body makes it possible to carry from 1 to 1½ yd. of sand, stone or gravel on the patrol graders at all times.

Iron Culvert with Paved Invert Combats Erosion

After extensive research on the subject of culvert erosion, caused by sedimentary streams, steep grades, and chemicals, separately or in combination, the Armco Culvert Manufacturers Association, Middletown, Ohio, has developed a pipe provided with a specially prepared invert pavement. The pipe is thus protected in its most vulnerable

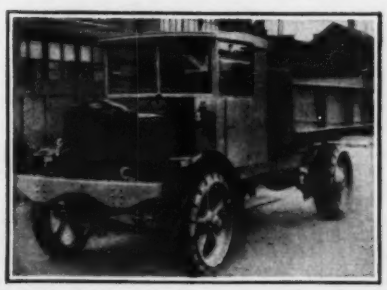
part against attack, and it is claimed that the culvert structure thus is given a practically uniform life throughout.

Early in the investigation the company's engineers decided that because of necessity for elasticity, the paving should be of a bituminous type. After subjecting many bituminous mixtures to test for erosion resistance, flexibility and resistance to deformation at high temperatures, the one was designed which is now used.

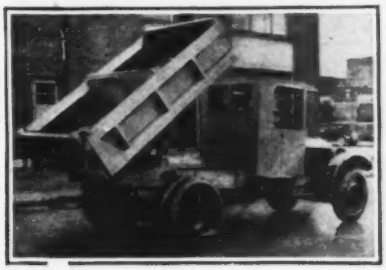
Three New Trucks Especially Designed for Road Work

Three different models of dump trucks, all particularly designed for highway construction and maintenance work, have been made available by the White Company, Cleveland, Ohio.

Model 52 in the first illustration, is



a heavy duty dump truck with auxiliary transmission, combining a power tower for operating the dumping mechanism



with an extra-low gear for operation in soft ground.

Model 51-A, shown in the second illustration, is a 2½ ton two-batch dump truck made with a short wheelbase especially adapted to road building work. The batches are of a size suitable for a 27-E mixer.

Model 15-B, in the third illustration,

is a one-ton dump truck with hydraulic underbody hoist, used generally in road maintenance work where a fast, small capacity dump truck is needed.

New Publications

Cement — LAWRENCE CEMENT COMPANY, New York City, has published a 20-page catalog, setting forth the advantages of its water-proof super cement, with illustrations, descriptive text and reports of its use on several projects. The catalog is designed to answer the questions of how, why, and where to use the company's Dragon brand cement.

Manufacturers and Trade Associations

Calendar

Annual Meetings

NATIONAL SAND AND GRAVEL ASSOCIATION, Washington, D. C.; Annual Convention, Detroit, Jan. 4-6, 1928.

ASSOCIATED EQUIPMENT DISTRIBUTORS, Milwaukee; Annual meeting, Cleveland, Jan. 6-7, 1928.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington, D. C.; Annual Convention, Cleveland, Ohio, Jan. 9-14, 1928.

NATIONAL CRUSHED STONE ASSOCIATION, Washington, D. C.; Annual Convention, West Baden, Ind., Jan. 16-19, 1928.

NATIONAL PAVING BRICK MANUFACTURERS ASSN., Chicago; Annual meeting, Chicago, Jan. 25-26, 1928.

Engineering News-Record Statistics of the Construction Industry

December Record Month For Contracts

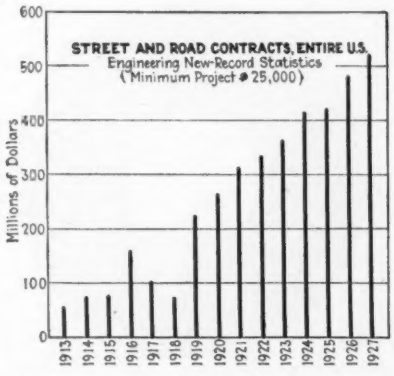
Street and Road Awards For 1927 100 Per Cent Higher Than In 1920

STREET and road contracts throughout 1927 show a gain of $40,171,000 or 8 per cent over 1926, according to *Engineering News-Record* statistics for projects of $25,000 or more. Total awards for this class of construction were $525,069,000, and this is about 16 per cent of all heavy construction awards in 1927—higher than any preceding year. Since 1913 there has been a consistent gain in street and road contracts except in 1917 and 1918. The year 1927 was just 100 per cent higher than 1920.

Total awards in the several sections of the country reflect varied trends but in all except New England and the South increases over 1926 have been shown. The Middle West increased 1 per cent, $656,000; the section between the Mississippi and the Rocky Mountains, 33 per cent, $31,512,000.

The Bureau of Public Roads has not completed compiling statistics of total rural roads constructed in 1926, but figures for state highways give a comparison of the 1925 with 1926. Disbursements for construction of roads and bridges for those years were $387,000,000 and $351,000,000 respectively. Total mileage surfaced and graded during 1925 and 1926 was 23,152 and 26,552, and the grand total mileage in state highway systems at the end of those years was 270,650 and 287,900, respectively. An estimate for 1927 would bring the total to more than 300,000 miles. Of this 64,000 miles have been improved with Federal assistance to the amount of $81,371,013 for the fiscal year ending June 30, 1927.

The annual highway bill is in excess of a billion dollars according to the annual report of the chief of the Bureau of Public Roads. *Engineering News-Record* figures representing expenditures on road and bridge construction in 1927 amounted to $668,741,000, or 17.6 per cent more than in 1926. Construction constitutes about 56 per cent of total road costs which include maintenance and administration. The road expenditures for 1927 amount to at least $1,190,000,000.



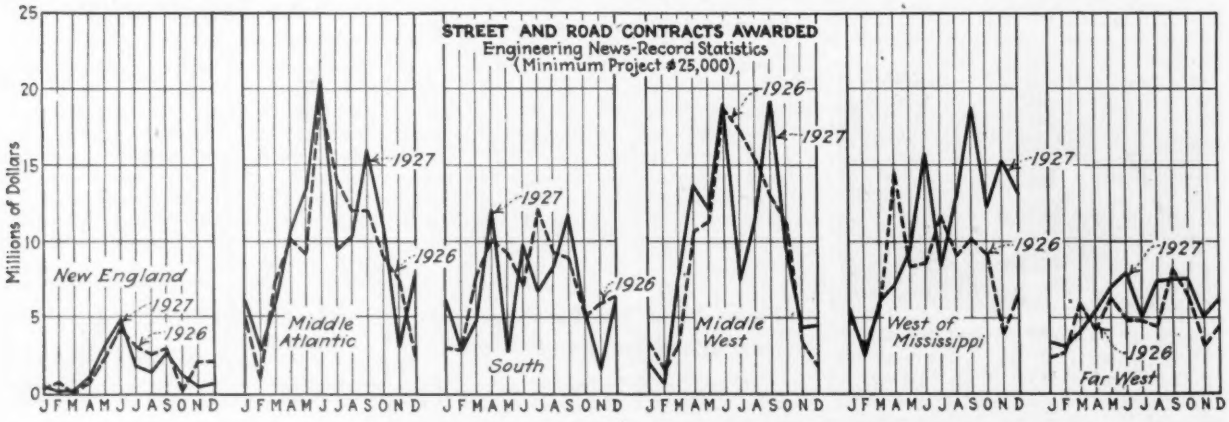
General Construction

December contracts average $76,500,000 per week, which is a record. It is $11,000,000 more than the weekly awards last month and $29,000,000 more than December, 1926, average weekly contracts.

Several outstanding projects contributed to this large total: a hydro-electric development in Missouri, several pipe lines, two subway contracts—all contributing about $70,000,000. An unusual amount of awards for commercial buildings in New York totaled $65,700,000.

Total contracts for 1927 are $3,253,766,000 compared with $2,853,842,000 in 1926—an increase of 14 per cent. Only waterworks declined, and the only geographic division less active than in 1926 is New England.

The *E. N.-R.* Construction Volume Index rose to 319 for December, averaging 263 for the year, which is 35 points above last year. The Cost Index for 1927 is 2 points under 1926.

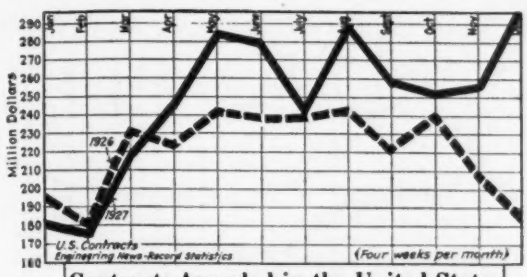


VALUE OF CONTRACTS BY SECTIONS IN THE UNITED STATES—DECEMBER, 1927

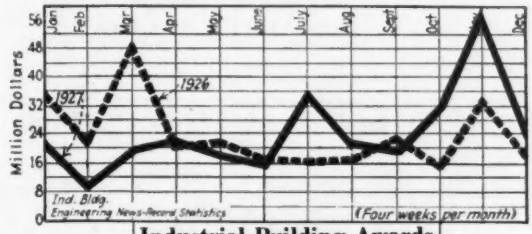
Thousands of dollars (-000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States	Total for 1927	Canada
Waterworks	$15	$684	$402	$124	$837	$493	$2,555	$53,189	$91
Sewers	.....	1,361	277	4,674	855	384	7,551	118,032	815
Bridges	5,025	1,868	2,810	4,387	942	733	15,765	143,645	338
Excavations, drainage, etc	.....	493	25	385	180	721	1,804	42,005	1,053
Streets and roads	648	7,835	6,385	4,495	13,114	6,136	38,613	525,069	94
Industrial buildings	3,891	13,006	6,659	4,965	2,633	806	31,960	321,315	2,883
Commercial buildings	10,764	90,923	3,895	44,945	10,083	15,021	175,631	1,632,328	44,175
Federal government	655	1,200	444	29	643	758	3,729	50,763	.....
Unclassified	652	16,755	9,152	2,723	70,663	291	100,236	387,410	1,627
December, 1927	$21,650	$134,125	$30,049	$66,727	$99,950	$25,343	$377,844	$2,853,847	$51,076
November, 1927	15,035	76,183	52,792	61,627	30,813	20,872	257,322	.....	11,355
December, 1926	19,746	65,051	19,572	57,709	30,858	36,667	229,603	.....	3,647
Total, 1927	234,274	988,994	290,465	775,955	533,417	370,661	3,233,766	.....	180,763
Total, 1926	246,595	856,327	288,891	724,428	414,962	322,644	2,853,847	.....	143,686

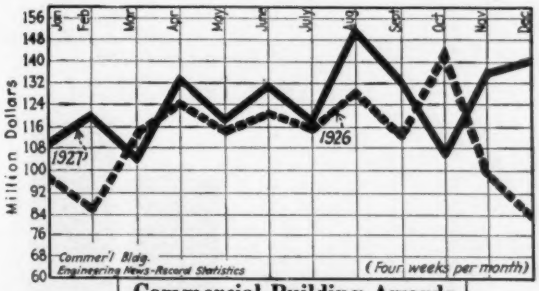
Monthly Statistics of the Construction Industry



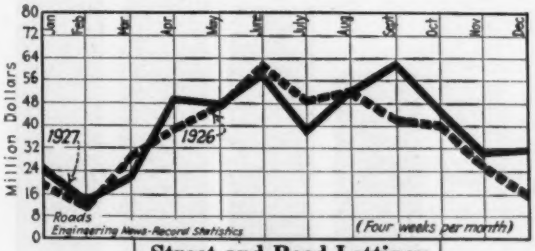
Contracts Awarded in the United States
Reported by E. N.-R.



Industrial Building Awards
$40,000 and Over

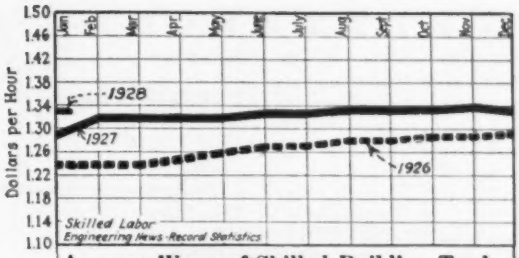


Commercial Building Awards
$150,000 and Over

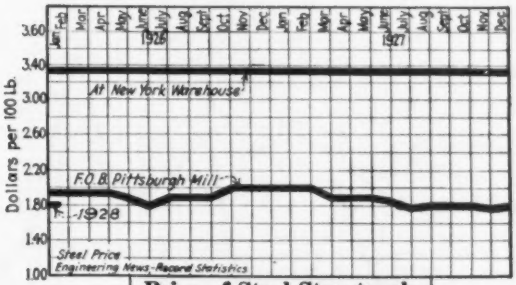


Street and Road Lettings
$25,000 and Over

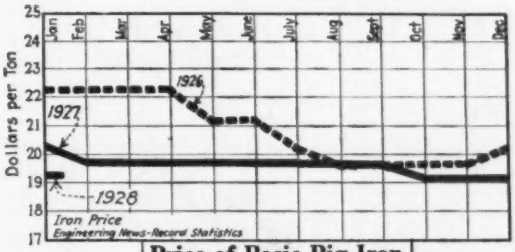
Average Common Labor Rate
Pick and Shovel Men



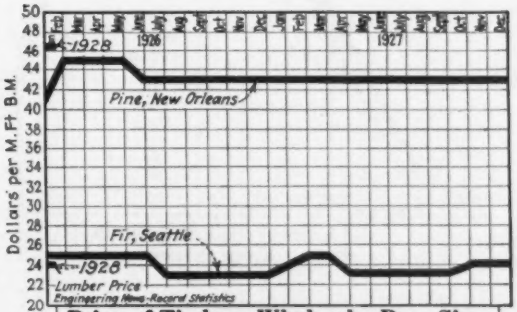
Average Wage of Skilled Building Trades
Bricklayers, Carpenters and Steel Erectors



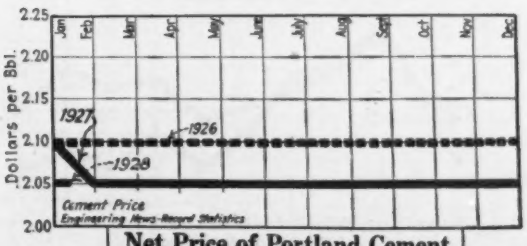
Price of Steel Structurals
Shapes 3-in; Plates ¼-in.



Price of Basic Pig Iron
F.o.b. Pittsburgh

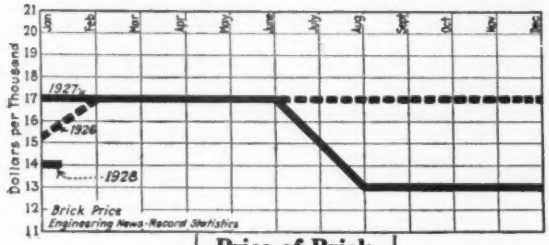


Price of Timbers, Wholesale, Base Sizes
Car Lots to Contractors

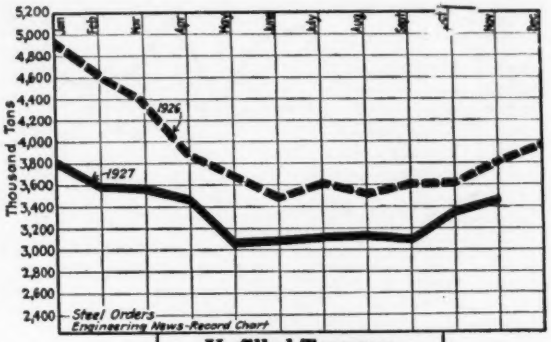


Net Price of Portland Cement
Car Lots F.o.b. Chicago

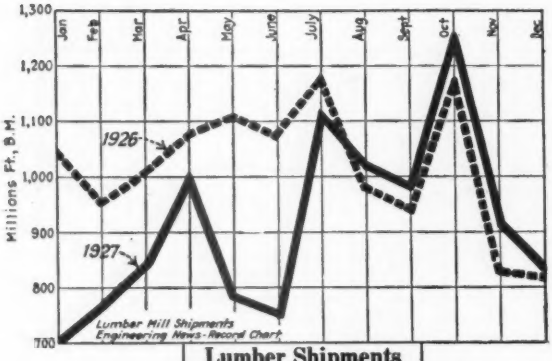
Monthly Statistics of the Construction Industry



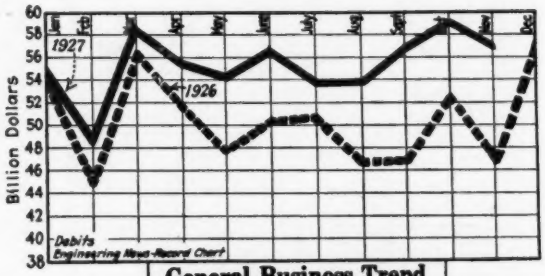
Price of Brick
At Dock, New York



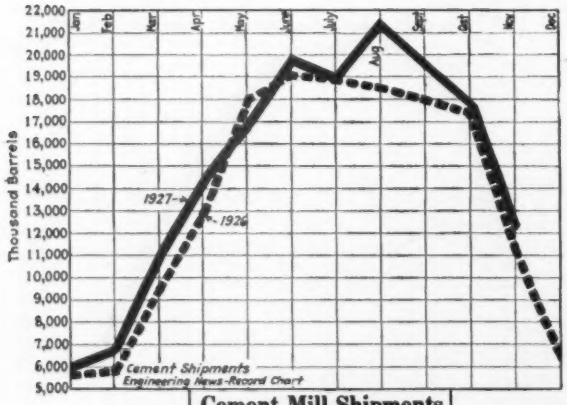
Unfilled Tonnage
On Books of U. S. Steel Corp.



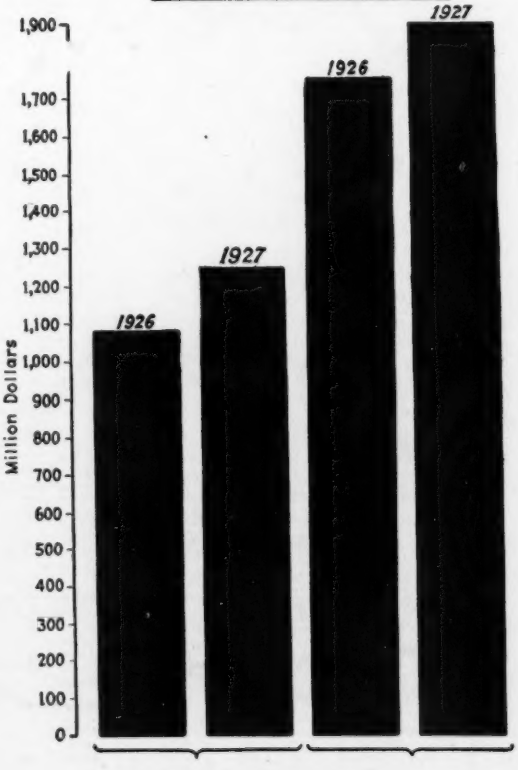
Lumber Shipments
Nat. Lumber Mfrs. Assn.



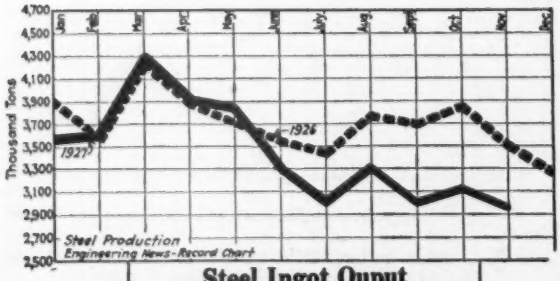
General Business Trend
Bank Debits—Federal Reserve



Cement Mill Shipments
Bureau of Mines



Public—Contracts—Private
Jan. 1 to date
Reported by E. N.-R.



Steel Ingot Ouput
Gross Tons; Am. Iron and Steel Inst.

ROAD WORK IN LAST TWO YEARS

	1926	1927
New England	$21,642,000	$18,226,000
Middle Atlantic	108,858,000	118,015,000
South	88,193,000	79,069,000
Middle West	111,272,000	111,928,000
West of Mississippi	96,648,000	128,160,000
Far West	58,285,000	69,671,000
Total U. S.	$484,898,000	$525,069,000

Labor Conditions

More Unemployment Noted In December—Fewer Strikes

SEVERAL of the major industries of the nation report an increase in unemployment during December. This recession is seasonal for construction, agriculture, and food packing. In the petroleum and shoe manufacturing industries, idleness is greater than normal. Iron, steel, and automotive industries are increasing plant forces.

The January level of skilled building trades wages is 0.2 per cent above that of the month preceding. The average hourly rate for common laborers is the same as on Dec. 1, 1927. Diagrams on p. 41 of this issue show the month to month movements of labor rates for both skilled and unskilled building workers.

These seven of the twenty-one cities reporting regularly to *Engineering News-Record*, show building conditions much slower than a month ago: Boston, Philadelphia, Detroit, Chicago, San Francisco, Los Angeles, and Seattle. In Detroit, the general employment situation has improved considerably, owing to renewal of activities in the automobile factories, although there is still a surplus of skilled labor.

A small strike last week in Boston involved wage demands among cement finishers and waterproofers.

Four cities report favorable developments during the month. In Pittsburgh, all building trades will ask higher wage rates than those applying on agreements which expired Dec. 31, 1927. Minneapolis bricklayers and plasterers were advanced to $1.37½ per hr., from $1.25, effective Jan. 1, 1928. Providence is experiencing a local building boom with heavy demand for laborers. In Birmingham, building conditions remain as good as during December.

Wage rates in trades not covered in the regular monthly table appearing in this section, are here given for San Francisco. Similar tables for other important cities were published in the following issues of *Engineering News-Record*: New York, Feb. 3, 1927, p. 217; Chicago, Nov. 3, 1927, p. 735; St. Louis, Dec. 1, 1927, p. 900. The foregoing schedules remain unchanged.

SAN FRANCISCO Craft	Rate per Day (8 hr.)
Asbestos workers	$7.50
Cabinet workers (shop)	8.00
Cabinet workers (outside)	9.00
Cement finishers	9.00
Electrical workers	9.00
Electrical fixture hangers	8.00
Elevator constructors	10.00
Engineers, stationary	8.00
Engineers, trav. cranes	8.00
Engineers, on derricks	8.50
Glass workers	8.00
Hardwood floormen	9.00
Housemovers	8.00
Housesmiths, arch. iron	9.00
Housesmiths, reinforced concrete	9.00
Iron workers (bridge and structural) including engineers	11.00
Laborers, building	5.50
Lathers	8.50
Marble setters	9.50
Marble cutters and copers	8.00
Marble bed rubbers	7.50
Marble polishers and finishers	7.00
Millmen, planing mill dept	7.50
Millmen, sash and door	6.50
Millwrights	8.00
Model makers	9.00
Model casters	7.50
Mosaic and terrazzo workers	8.00
Painters	9.00
Painters, varnishers and polishers (shop)	8.00
Painters, varnishers and polishers (outside)	9.00
Pile drivers and wharf builders (including engineers)	9.00
Plasterers	11.00
Plasterers' hodcarriers	7.50
Plumbers	9.50
Rodmen (re-inforced concrete)	9.00
Roofers [illegible]sition	8.00
Sheet meta[illegible]	9.00
Sprinkler fitters	8.00
Steam fitters	9.50
Stair builders	9.00
Stone cutters, soft and granite	8.50
Stone setters, soft and granite	9.00
Stone carvers	8.50
Stone derrickmen	9.00
Tile setters	10.00
Auto truck drivers—less than 2,500 pounds	5.50
Auto truck drivers—2,500 pounds to 4,500 pounds	6.00
Auto truck drivers—4,500 pounds to 6,500 pounds	6.50
Auto truck drivers—6,500 pounds and over	7.00
General teamsters, 1 horse	5.50
General teamsters, 2 horses	6.00
General teamsters, 4 horses	6.50
Plow teamsters, 4 horses	6.50
Scraper teamsters, 2 horses	6.00
Scraper teamsters, 4 horses	6.00

CURRENT BUILDING TRADES WAGE RATES PER HOUR

(Higher rates than a month ago indicated by +, decreases by —)

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1.40	$0.70	$0.70	$0.50	.....	$0.75	$0.25@.30
Baltimore	1.62½	1.00@1.10	1.00@1.37½	1.00	$0.65	1.20@1.25	—.35
Birmingham	1.00@1.50	1.05	1.00	.50@.75	.....	1.75	.25@.40
Boston	1.40	1.25	1.25	.79	1.15	1.25	.45@.74
Cincinnati	1.50	1.37½	1.37½	.97½	1.37½	1.37½	.45@.60
Chicago	1.62½	1.50	1.00@ 1.50	.90@.96½	1.50	1.50	.90
Cleveland	1.62½	1.37½	1.37½	.87½	1.10	1.50	.87½
Dallas	1.62½	1.12½	1.00	.40@.75	1.00	1.25	—.30@.50
Denver	1.50@1.62½	1.25	1.25@1.37½	.87½@1.00	.....	1.25	.31½@.50
Detroit	1.56½	1.00@1.25	1.00@1.10	.90	1.00@1.10	1.00@1.25	.50@.60
Kansas City	1.50	1.25	1.25	.90	1.25	1.25	.35@.75
Los Angeles	1.37½	1.00	1.00	—.81½	—1.12½	1.00	.50
Minneapolis	+1.25@1.37½	.87½@.95	.87½	.75	.....	1.00	.45@.60
Montreal	1.25	.75	.75	.40	.50	—.75@.90	.30@.35
New Orleans	1.50	.90	1.25	.75	.80@1.00	1.25	.30@.40
New York	1.75	1.50	1.75	1.12½	1.00@1.12½	1.75	.90½
Philadelphia	1.62½	1.12½@1.25	1.02½	.70@1.12½	1.00	1.37½@1.50	.45@.50
Pittsburgh	1.70	1.50	—1.37½@1.50	1.12½	.....	1.50	.50@.80
St. Louis	1.75	1.50	1.50@1.65	1.15@1.25	1.25	1.50	.45@.75
San Francisco	1.37½	1.12½	1.00@1.12½	.87½	1.12½	1.37½	.50@.60
Seattle	1.37½	1.12½	1.00@1.12½	1.00	1.00@1.12½	1.12½@1.25	.62½@.70

Materials Prices

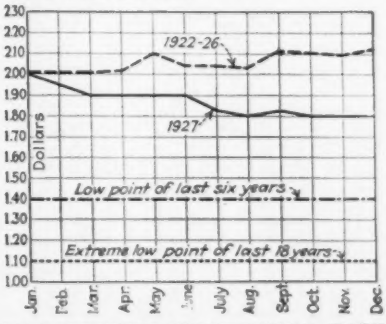
Declines In Cement and Cast-Iron Pipe Feature Materials

BUILDING materials prices declined 1.5 per cent in December.

Recessions occurred mainly in lumber, brick, paint stuffs, and the minor materials. Cement held to December levels except for slight reductions in the Middle West. Steel prices are gaining strength, since the adoption of the $1.80 per 100 lb. base, on the principal hot-rolled products, by both corporation and independents.

Cast-iron pipe prices remain at the $27.50 per ton base, for 6-in., Class B, Birmingham. The price at Burlington, N. J., dropped $1 (to $35 per ton), causing a similar decline in the New York market.

Portland cement, quoted at $2.32 per bbl., net, f.o.b. Cincinnati, in large lots, is now $2.23, exclusive of the cost of bags. Continued construction of new cement mills is causing close competition in the Ohio district.



REINFORCING BARS, PER 100 LB., BASE, PITTSBURGH, IN CARLOAD LOTS

The movement of the market in steel reinforcing bars, compared with earlier years, is fairly representative of conditions in structural shapes and plates.

The current price of steel reinforcing bars is 15 per cent below the December average for the 1922-26 period, according to compilations of price movements in this material, made by *Engineering News-Record*.

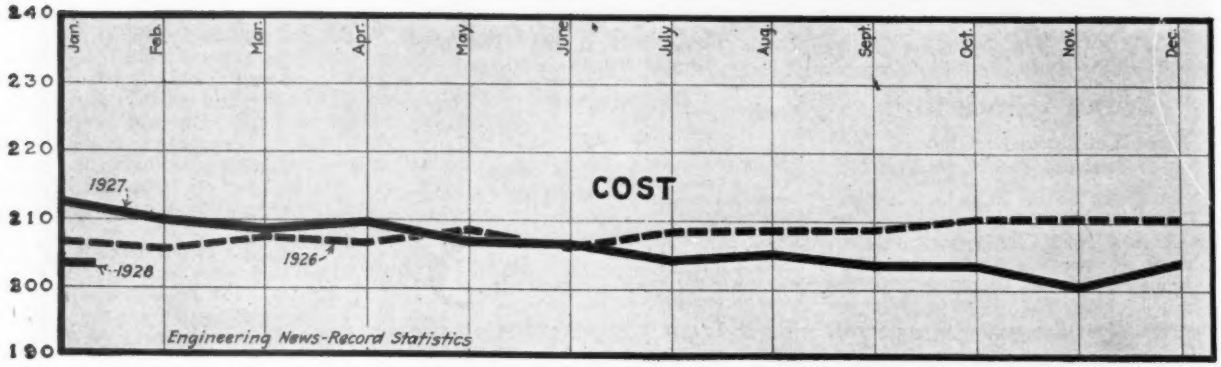
Prices shown in the accompanying diagram are based on billet-steel bars, ¾-in. and heavier, per 100-lb., f.o.b., Pittsburgh, in carload lots or over. The December quotation is 29 per cent above the lowest point touched in the last six years.

It is unlikely, judging from recent developments in the steel market, that the downward trend depicted in the chart will continue throughout the first quarter of 1928.

If bars advance to $1.90 in January, the level will then be 10c. per 100-lb. below the high point of 1927, which occurred in the first month of the year. The price of $1.90 prevailed from March to June, 1927, and also during June, 1926, at which point it constituted the minimum for that year.

Bars did not sell below $1.95 in 1925 nor under $2 in either of the two preceding years.

Engineering News-Record Index Numbers



Engineering News-Record CONSTRUCTION COST Index Number (1913 = 100)

MONTHLY

January, 1926, to Date

January, 1928	**203.90**
December, 1927	203.90
January, 1927	211.50
Peak, June, 1920	273.80
1913	100.00

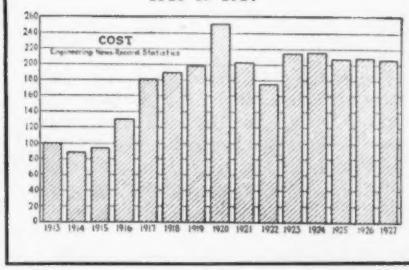
1926					
Jan.	207.15	May	207.30	Sept.	208.30
Feb.	206.55	June	204.80	Oct.	209.80
Mar.	207.65	July	207.80	Nov.	210.80
April	207.05	Aug.	208.30	Dec.	210.80

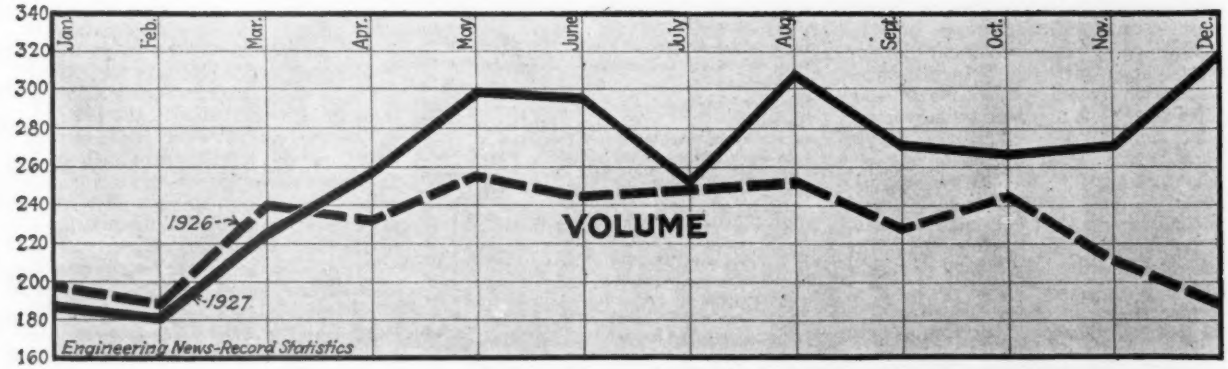
1927					
Jan.	211.50	May	206.80	Sept.	203.60
Feb.	210.15	June	205.55	Oct.	204.40
Mar.	208.80	July	203.68	Nov.	201.98
April	209.00	Aug.	205.50	Dec.	203.90

Engineering News-Record's Construction Cost Index Number is unchanged from the December, 1927, level. The average rate for common laborers continues at 55c. per hour as against 55¼c. at this time last year. Thus, general construction cost is 3.5 per cent below January, 1927, and 25 per cent under the peak. It is also 103 per cent above 1913.

YEARLY

1913 to 1927





Engineering News Record CONSTRUCTION VOLUME Index Number (1913 = 100)

MONTHLY

January, 1926, to December, 1927

December, 1927	**319**
November, 1927	272
December, 1926	188
1913	100

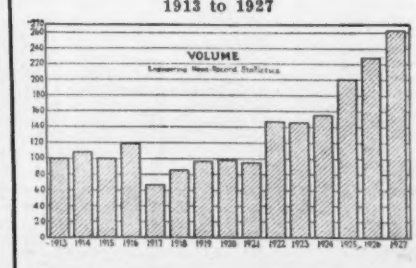
1926					
Jan.	198	May	254	Sept.	227
Feb.	187	June	246	Oct.	244
Mar.	240	July	248	Nov.	211
April	233	Aug.	252	Dec.	188

1927					
Jan.	187	May	299	Sept.	273
Feb.	182	June	297	Oct.	269
Mar.	226	July	252	Nov.	272
April	257	Aug.	306	Dec.	319

Engineering News-Record's Construction Volume Index Number is 319 for the month of December and 263 for the whole of 1927, as against 100 for 1913. This means that the actual volume of contract letting in 1927 (not the mere money-value of the contracts let that year) is 163 per cent above the volume for 1913. The monthly volume number, 319 for December, 1927, indicates the rate at which contracts are being let as compared with 1913 awards.

YEARLY

1913 to 1927



E. N.-R. Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per gross ton, f.o.b.:

	Jan. 5	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25@2.75)	$21.44	$24.19
Northern Basic	20.89	20.89
No. 2 Southern Ohio (silicon 1.75@2.25)	21.19	21.39
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25@2.75)	25.62	26.37
BIRMINGHAM		
No. 2 Foundry (silicon 2.25@2.75)	16.00	20.00
PHILADELPHIA		
Eastern Pa., No. 2X (2.25@2.75 sil.)	21.76	23.76
Virginia No. 2 (silicon 2.25@2.75)	27.17	28.19
Basic	21.26	21.26
CHICAGO		
No. 2 Foundry Local (silicon 1.75@2.25)	20.00	21.00
No. 2 Foundry Southern (silicon 2.25@2.75)	22.80	24.55
PITTSBURGH, including freight charge ($1.76) from the Valley		
No. 2 Foundry Valley (silicon 1.75@2.25)	20.26	20.76
Basic	19.26	20.26
Bessemer	21.26	21.26

SCRAP—The prices following are f.o.b. per ton paid by dealers:

	New York	Chicago
No. 1 railroad wrought	$10.50@$11.00	$10.75@$11.25
Stove plate	8.75@ 9.25	12.00@ 12.50
No. 1 machinery cast	13.50@ 14.00	14.00@ 14.50
Machine shop turnings	6.50@ 7.50	7.00@ 7.50
Cast borings	6.75@ 7.25	9.00@ 9.50
Railroad malleable	10.00@ 10.50	11.25@ 11.75
Re-rolling rails	10.50@ 11.00	13.00@ 13.50
Re-laying rails	23.00@ 24.00	
Heavy melting steel	6.25@ 10.75	11.00@ 11.50
Iron and steel pipe	8.75@ 9.25	

Railway Supplies

STEEL RAILS—The following quotations are per gross ton f.o.b. for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh		Birmingham	Chicago	St. Louis
	Jan. 5	One Year Ago			
Standard bessemer rails	$43.00	$43.00	$43.00	$43.00	.....
Standard openhearth rails	43.00	43.00	43.00	43.00	$49.50
Light rails, 8 to 10 lb.	.....	.....	34@36	1.80@1.90*	*1.85**
Light rails, 12 to 14 lb.	36.00	.....	34@36	1.80@1.90*	*1.765**
Light rails, 25 to 45 lb.	36.00	36.00	34@36	1.80@1.90*	*1.78**
Re-rolled rails	30@34	27@30	34@36	34@36	.....

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, white oak, plain	*$1.40*	*$1.78*
Chicago, empty cell creosoted	*1.80*	*2.40*
Chicago, zinc treated	*1.60*	*2.10*
San Francisco, green Douglas fir	.84	1.14
San Francisco, empty cell creosoted, Douglas fir	1.70	2.25
St. Louis, white oak, plain	1.25	1.50
St. Louis, zinc treated	1.65	1.90
St. Louis, red oak, plain	1.15	1.40
St. Louis, sap pine-cypress	.95	1.20
Birmingham, white oak	1.25	1.45

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh mill for carload lots, together with the warehouse prices at the places named:

	Pittsburgh					
	Jan. 5	One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅞-in. and larger	$2.70@$2.80	$2.80@2.90	$3.55	$3.65	$3.85	$3.00
Track bolts	3.80	3.90@4.25	4.55	4.65	5.35	3.90
Standard section angle bars, splice bars or fish plates	2.75	2.85	3.40	4.25	4.25	2.95
Tie plates	2.25	.....	....	....	....	....

Pipe

WROUGHT STEEL AND IRON PIPE—The following discounts from list are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

1	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
2 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 to 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

WROUGHT-STEEL PIPE—From warehouses at the places named the following discounts from list, hold for welded steel pipe:

	Black		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	53%	54%	49%
2½ to 6 in. lap welded	48%	51%	46%
	Galvanized		
	New York	Chicago	St. Louis
1 to 3 in. butt welded	39%	41%	36%
2½ to 6 in. lap welded	35%	38%	33%

Malleable fittings, Classes B and C, banded, from New York stock sell at list plus 4% less 5%. Cast iron, standard sizes, 36—5% off.

CAST-IRON PIPE—The following are prices per net ton for Class B and heavier, f. o. b., in carload or larger lots:

	Birmingham	Burlington, N. J.	New York Jan. 5	New York One Year Ago
4 in.	$30.50	*$38.00*	*$40.60*	$52.60
6 in. and over	27.50	*35.00*	*37.60*	48.60
	Pittsburgh	Chicago	St. Louis	San Francisco
4 in.	$39.00	$38.70	$36.10	$51.50
6 in. and over	36.00	35.70	33.10	48.50

Gas pipe and Class "A," $3.00 per ton extra.

CLAY DRAIN TILE—The following prices are per 1,000 lin.ft.:

Size, In.	New York Jan. 5	New York One Year Ago	St. Louis	Birmingham	San Francisco	Dallas
3	$45.00	$45.00	.....	$45.00	.....	$73.00
4	56.00	55.00	$35.00	56.00	$76.50	90.00
5	.....	.....	.....	80.00	97.75	118.00
6	90.00	90.00	65.00	100.00	127.50	150.00
8	150.00	160.00	150.00	165.00	212.50	210.00

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In.	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	....	$0.072	$0.10	.....	$0.088	$0.12	.....
4	....	.072	.10	$0.0875	.088	.15	$0.15
5	....	.099	.135	.....	.11	.18	.18
6	$0.22	.099	.21	.1225	.11	.21	.21
8	.36	.162	.315	.20	.18	.30	.38
10	.52	.2415	.45	.28	.2625	.42	.55
12	.66	.3105	.54	.36†	.3375	.56	.70
15	1.12†	.414	.75	.60†	.45	.92	1.02
18	1.62†	.575	.90	.84†	.875†	1.32	1.32
20	1.95†	.69	1.20	.....	1.05†	.....	.....
21	.....	.805	.....	1.12†	1.225†	.....	.....
22	2.60†	.92	1.35	.....	1.40†	.....	1.83
24	2.92†	1.035	2.665	1.44†	1.575†	2.16	2.27
27	4.62†	2.08	2.952	2.45†	2.75†	3.00	3.34
30	5.12†	2.304	3.96	3.00†	3.75†	3.60	4.06
33	6.93†	4.05	4.51	3.55†	4.50†	....	4.99
36	7.91†	4.6125	5.06	3.95†	5.00†	.....	5.42

	3	5	8	12	24	36
Boston	$0.125	$0.175	$0.25	$0.47	$1.80†	$5.00†
Minneapolis	.....	.....	.25	.45	1.50	4.56
Denver	.135*	.18*	.27	.47	1.70	.....
Seattle	.14	.....	.35	.63	2.52	.....
Los Angeles	1675	.186	.2825	.5085†	2.034†	.....
New Orleans	.11*	.165*	.275	.4675	1.7875	3.50
Cincinnati	.105	.1575	.245	.4725	1.575	4.715
Atlanta	.10*	.15*	.25	.425	1.625	.....
Montreal	....	.25	.45	.675	2.25	.....
Detroit	.081	.122	.189	.405	2.07†	4.715†
Baltimore	.111	.166	.259	.499	1.665	4.92
Kansas City, Mo.	.15*	.21	.29	.52	1.90†	3.80†
Philadelphia	.10	.14	.235	.38	1.33	3.32

*4-in., 6-in., 9-in., respectively. †Double Strength.

Road and Paving Materials

ROAD OILS—Following are prices per gal. in tank cars, 8,000 gal. minimum, f.o.b., places named:

		Jan. 5	One Year Ago
New York, 45% asphalt	(at terminal)	$0.0725@$0.075	$0.065@$0.075
New York, 65% asphalt	(at terminal)	.0675@.0725	.0675@.0725
New York, binder	(at terminal)	.07 @ .075	.07 @.075
New York, flux	(at terminal)	.07 @ .075	.07 @.075
New York, liquid asphalt	(at terminal)	.07 @ .075	.07 @.075
St. Louis, 40@50% asphalt		.052	.0503
St. Louis, 50@60% asphalt		.0554	.0523
Birmingham, 55% asphalt		.0475	.0475
Dallas, 45% asphalt		.0495	.0495
Dallas, 50% asphalt		.0455	.0455
Dallas, binder		.061	.061
San Francisco, binder, per ton		12.00*	12.00*

* F.o.b. Oleum, Cal. Freight to San Francisco, 88c. per ton.

E. N.-R. Prices of Construction Materials

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Texas*)	$24.50	.....
Boston (*Mexican*)	**24.00**	$19.00
Chicago (*Texas*)	24.00	18.50
San Francisco, *f.o.b. refinery*, Oleum, Cal.	18.00	12.00
Dallas (*Texas*)	27.10	21.10
Seattle, *"D" grade, California, f.o.b. Richmond*	19.50	13.50
Denver (*California*)	24.00	.....
Minneapolis, *f.o.b. Twin Cities* (*Stanolind*)	28.10	22.10
St. Louis (*Mexican*)	26.00	23.00
Baltimore (*Standard Oil*) (*f.o.b. refinery*)	22.50	18.50
Montreal (*Imperial*)	**28.00**	*21.50*
Atlanta (*Mexican*)	24.40	19.40
Detroit (*Mexican*)	24.00	19.00
Cincinnati (*Kentucky Rock*)	.....	11.65
Maurer, N. J. (*Bermudez*)	30.00	.....
Maurer, N. J. (*Trinidad*)	23.00	.....
Philadelphia (*Mexican*)	20.00	18.00
Kansas City, Mo. (*Texas*)	**28.30**	**25.00**
Los Angeles (*"D" grade, California*)	*18.00	*12.00
Birmingham (*Mexican*)	27.00	21.00
New Orleans (*Mexican*)	20.00	17.00

*F.o.b. El Segundo Refinery. Drums used in New York.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton.

PAVING STONE—

New York (grade I)	5-in. granite, 30 blocks per sq.yd.	$150.00 per M.
San Francisco	Basalt block 4x7x8	70.00 per M.
Chicago	about 5x8x5 dressed	3.60 per sq.yd.
	about 5x8x5 common	3.25 per sq.yd.
Boston	5-in. Granite	135.00 per M.
Atlanta	Granite	2.50 per sq.yd.
Detroit	5-in. Granite	3.00 per sq.yd.
Baltimore	Granite	2.85 per sq.yd.
Montreal	Granite	104.75 per M.
New Orleans	Granite, 4x8x4	2.75 per sq.yd.
Cincinnati	Granite	135.00 per M.
St. Louis	Granite, 4x8x4	1.65 per sq.yd.
Kansas City	Granite	3.85 per sq.yd.
Philadelphia	Granite	3.90@4.25 per sq.yd.
Minneapolis	Sandstone	2.74 per sq.yd.

FLAGGING—

New York	Bronx, 4 ft. wide	$0.24 per sq.ft.
	Manhattan, 4 ft. wide	.24 per sq.ft.
	Queens, 5 ft. wide	.26 per sq.ft.
	6x24-in. cross-walk.	1.30 per lin.ft.

CURBING—*New York*: Bluestone, per lin.ft., f.o.b. barge, New York, 5x16 in., 90c. *St. Louis*: Class "A" straight, delivered, 5x18 in., 90c. per lin.ft.; roundings, $1.55 per lin.ft. *Birmingham*: Limestone, 5x18-in., $1.05 per lin.ft.

WOOD BLOCK, PAVING—	Size of Block	Treatment	Per Sq. Yd.
New York	3	16	$2.40
New York	3½	16	2.70
Boston	3½	18	**2.45**
Chicago	4	16	2.25
Chicago	3½	16	2.10
St. Louis	3½	16	2.30
St. Louis	4	16	2.55
Seattle	4	16	Off market
Minneapolis	3½	16	2.50
Atlanta	3½	16	2.00
New Orleans	3	16	2.20
New Orleans	3½	16	2.30
New Orleans	4	16	2.40
Dallas	4	18	3.90
Baltimore	3½	16	None used
Montreal	4	16	4.50
Detroit	3	16	1.94
Cincinnati	3½	16	2.35
Kansas City	4	16	2.50
Philadelphia	4	16	None used

Construction Materials

SAND AND GRAVEL—Price for cargo or carload lots to contractors, f.o.b., per cu.yd. Weight of sand, 1½ tons per cu.yd.; gravel, 1½ tons per cu.yd. unless otherwise specified in pounds.

	Gravel 1½ In.		Gravel ¾ In.		Sand	
	Jan. 5	One Year Ago	Jan. 5	One Year Ago	Jan. 5	One Year Ago
New York (*alongside dock*)	$1.75	$1.75	$1.75	$1.75	$1.00	$1.00
Denver (*2,700*)	1.90	1.90	1.90	1.90	1.00	1.00
Chicago	2.75†	1.85	2.75†	1.85	2.75†	1.65
St. Louis	1.45*	1.45*	1.45*	1.45*	1.20*	.93‡
Seattle (*3,200*) (*2,850*)	*1.00*	1.25	*1.00*	1.25	*1.00*	1.25
Dallas	2.38	2.38	2.38	2.38	2.00	2.00
Minneapolis (*2,800*)	1.25*	1.65*	1.25*	1.65*	1.25†	1.25†
Cincinnati	1.30*	1.30*	1.30*	1.30*	1.05*	1.05*
San Francisco (*2,800*)	1.80	1.80	1.80	1.80	**1.80**	1.40
Boston (*on trucks at dock*)	1.75*	1.75*	1.75*	1.75*	1.25*	1.25*
New Orleans (*2,700*)(*2,500*)	1.95	.....	1.95	.....	1.40	1.80
Los Angeles	**2.10***	1.95*	**2.10***	1.95*	1.40*	1.70*
Atlanta	.....	1.90	.....	1.90	1.75	1.60
Detroit (*2,600*)	1.70	1.70	1.60	1.60	1.35	1.35
Baltimore	1.40	1.40	1.60	1.60	.70‡*	.70‡*
Montreal	1.90*	1.50*	1.50*	1.50*	1.35*	1.25*
Birmingham (*2,700*)	1.54	2.00	1.54	2.00	1.19	1.50
Philadelphia (*2,950*)	2.25	2.25	2.25	2.25	1.65	1.65
Kansas City, Mo.	.....	.....	.....	.....	.66‡*	.66‡*
Pittsburgh	.85‡*	.....	1.05‡*	.....	1.25*	.....

*Per ton †Delivered. ‡At pit. Note: New York in truckload lots; gravel weighs 2,800@3,000 lb. and sand, 2,700 lb.

CRUSHED STONE—Prices are for cargo or carload lots, per cu.yd., f.o.b. city Weight 1½ tons per cu.yd., unless otherwise specified in pounds:

	1½ In.		¾ In.	
	Jan. 5	One Year Ago	Jan. 5	One Year Ago
New York (*)	$1.75	$1.84	$1.85	$1.94
Chicago (*L*)	2.75†	1.70	2.75†	1.87½
St. Louis	1.73*	1.83*	1.73*	1.93*
Dallas	2.40	2.40	*2.75*	2.83
San Francisco (*T*) (*2,400*)	1.70	1.70	1.70	1.70
Boston (*on trucks at dock*)	2.00*	1.60*	2.00*	1.60*
Minneapolis (*L*) (*2,660*)	1.25*	1.75*	1.25*	1.75*
Kansas City (*L*) (*2,450*)	2.00	2.00	2.00	2.00
Denver (*G*) (*2,700*)	2.50	2.50	2.50	2.50
Seattle (*2,700*)	*1.90*	.....	*1.90*	.....
Atlanta	.....	2.50	.....	2.50
Cincinnati	1.65*	1.65*	1.65*	1.65*
Los Angeles	**2.10***	2.10*	**2.10***	2.10*
Detroit (*L*) (*2,600*)	2.60	2.60	2.60*	2.60*
Baltimore	2.50	2.50	2.55	2.55
Montreal	1.80*	1.80*	2.00*	2.00*
Philadelphia (*L*) (*2,590*)	2.25	2.10	2.25	2.10
Pittsburgh	2.75*	2.85*	2.75*	2.85*
Cleveland	2.70*	2.70*	2.70*	2.70*
Birmingham (*L*)	.85‡	2.00	1.00‡	2.00

*Per ton. †Delivered. ‡At Crusher. *L*-Limestone. *G*-Granite. *T*-Trap rock. Note: New York in truck-load lots.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plant

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.40	$2.00	$1.30
Buffalo District	1.25	1.35	2.25	1.25
Birmingham, Ala.	.90	1.25	2.05	.80
Cleveland, Ohio	1.20	1.20	.....	1.30
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	1.50	1.25

LIME—Warehouse or wholesale prices:

	Hydrated, per Ton		Lump, per Barrel	
	Finishing	Common	Finishing	Common
New York	*$17.20@18.20*	$12.10	*$3.25*@$3.50*	*$2.10*@2.50*
Chicago (*del.*)	20.00	18.00	.....	1.50†
St. Louis	23.50	17.50	.....	2.03*
Boston	19.00	12.00	3.50*	2.25@2.50*
Dallas	19.00	.....	.....	1.82†
Cincinnati	16.80	11.90	.....	11.40‡
San Francisco (*del.*)	27.50	24.50	.....	1.70†
Minneapolis (*del.*)	25.50	21.00	.....	1.70†
Denver	24.00	.....	.....	2.70*
Detroit	15.50	11.50	.....	12.00‡
Seattle, *paper sacks*	24.00	.....	.....	2.80*
Los Angeles	26.00	18.00	2.40†	14.00‡
Baltimore	24.25	*13.00*	2.55†	.....
Montreal	.....	21.00	.....	10.00‡
Atlanta	**22.50**	12.50	.....	1.50†
New Orleans	.....	.....	.....	2.00*
Philadelphia	23.00	15.00	.....	.....
Kansas City	19.00	17.50	2.50*	2.25*
Birmingham	22.50	16.00	2.40†	1.85†

*Per 280-lb. bbl. (net). †Per 180-lb. (net). ‡ Per ton.

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, exclusive of bags:

	Jan. 5	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	**1.45**	1.40
Cincinnati (Utica)	1.72	1.72
Boston (Rosendale)	2.35	2.65
St. Louis (Carney)	2.60	2.35
Birmingham (Magnolia) pozzolan cement	2.40	2.40

PORTLAND CEMENT—Prices to contractors, per bbl. in carload lots, f.o.b. points listed, *without charge for bags*. Cash discount not deducted.

	Jan. 5	One Month Ago	One Year Ago
New York, del. by truck	$2.25@$2.35	$2.35	$2.50@$2.60
New York, alongside dock to dealers	2.03	2.03	2.15
Jersey City	2.13	2.13	2.33
Boston	2.05	2.05	2.35
Chicago	2.05	2.05	2.10
Pittsburgh	2.04	2.04	2.09
Cleveland	2.24	2.24	2.29
Detroit	2.00	2.00	2.15
Indianapolis	2.19	2.19	2.29
Milwaukee	2.20	2.20	2.25
Duluth	2.04	2.04	2.09
Peoria	2.22	2.22	2.27
Cedar Rapids	2.24	2.24	2.24
Davenport	2.24	2.24	2.29
St. Louis	2.05	2.05	2.20
San Francisco	2.51	2.51	2.31
New Orleans	2.07	2.07	2.40
Minneapolis	2.22	2.22	2.22
Denver	2.85	2.85	2.85
Seattle	2.65	2.65	2.65
Dallas	2.05	2.05	2.05
Atlanta	2.45	2.45	2.35
Cincinnati	*2.23*	2.32	2.37
Los Angeles	*2.50*	2.56	2.50
Baltimore	2.50	2.50	2.50
Birmingham	2.40	2.40	2.40
Kansas City, Mo.	2.07	2.07	2.05
Montreal	1.41	1.41	1.41
Philadelphia	2.40	2.40	2.50
St. Paul	2.22	2.22	2.22
Toledo	2.20	2.20	2.20

NOTE—Bags 10c. each, 40c. per bbl.; 20c. each in Canada, 80c. per bbl.

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind.	$1.80	Hudson, N. Y.	$1.75
Universal, Pa.	1.80	Leeds, Ala.	1.65
Steelton, Minn.	1.85	Hannibal, Mo.	1.90
Fordwick, Va.	2.05	Lehigh Valley District	1.75
Mitchell, Ind.	1.90	Wyandotte, Mich.	1.75
Iola, Kan.	1.85	Alpena, Mich.	1.60
Mason City, Ia.	1.80	Kingsport, Tenn.	2.05
La Salle, Ill.	1.90	Clinchfield, Ga.	1.65
		Richard City, Tenn.	$1.85

E. N.-R. Prices of Construction Materials

TRIANGLE MESH—Price per 100 sq.ft. in carload lots at mills; from warehouse, in less-than-carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse: New York	St. Louis	Dallas	San Francisco
052	22	$0.99	$1.01	$1.39	$1.06	$1.13	$1.22
049	28	1.26	1.29	1.76	1.35	1.38	1.55
058	35	1.54	1.58	2.16	1.66	1.67	1.91
093	45	1.98	2.03	2.77	2.13	2.00	2.46
126	57	2.45	2.51	3.45	2.63	2.55	3.03
153	68	2.92	2.99	4.11	3.14	3.15	.....
'80	'78	3.35	3.43	5.70	3.60	3.47	.....
245	103	4.43	4.53	6.21	4.75	4.58	.....
287	119	5.12	5.24	7.19	5.50	5.26	6.35
336	138	5.93	6.07	8.35	6.37	6.11	.....
395	160	6.88	7.04	9.65	7.38	7.12	.....
PAVING							
036P	17	$0.76	$0.77	$1.06	$0.81	$0.76	.....
053P	24	1.07	1.09	1.50	1.14	1.07	.....
072P	31	1.35	1.38	1.90	1.45	1.39	.....
097P	40	1.74	1.78	2.45	1.87	1.90	.....
049R	24	1.07	1.09	....	1.14	1.02	.....
067R	31	1.35	1.38	....	1.45	1.39	.....
089R	40	1.74	1.78	....	1.87	1.90	.....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq.ft.

EXPANDED METAL LATH—Prices in less-than-carload lots per 100 yd. for painted:

Weight in pounds	New York	Birmingham	Chicago	St. Louis	San Francisco	Dallas
2.2	$17.50	$19 50	$17.50	$16.50	$17.00	$24.00
2.5	18.50	21.50	18.50	17.50	19.00	26.00
3.0	21.00	24.50	21.00	20.00	22.00	29.00
3.4	22.50	27 50	22.50	21.50	24.00	31.00

BARS, CONCRETE REINFORCING—Price per 100 lb., in carload lots, f.o.b. Pittsburgh mill, and Birmingham. In other cities listed, prices are for bars out of stock at warehouse.

ROLLED FROM BILLETS

Inches	Pittsburgh	Birmingham	Warehouse: New York	Chicago	St. Louis	Dallas	San Francisco
½ and larger..	$1.80	$2 00	$3.24	*$2.30*	$3.15	$2.75	$2.95
⅝.....	1 90	2 10	3.34	*2.40*	3.25	2.85	3.05
¾.....	2.00	2.20	3.44	*2.50*	3.35	2.95	3.15
⅞.....	2 20	2.40	3.64	*2.70*	3.55	3.10	3.35
1.....	2.80	3.00	4.24	*3.30*	4.15	3.75	3.95

For standard classification of extras for size and cutting of steel bars, see bar card of July 15, 1923.

ROLLED FROM RAILS

	Warehouse: St. Louis	Dallas		St. Louis	Dallas
½ in and larger	$2.20	$2.48	½.....	$2.60	$2.88
⅝	2 30	2.58	¾.....	3.20	3.48
⅞.....	2 40	2.68	.....	....	.....

BRICK—Contractors price, f.o.b., per M, in cargo or carload lots, is as follows:

	Common: Jan. 5	One Month Ago	One Year Ago	Paving: 3x8½x4-in.	3½x8½x4-in.
New York (del.*)...	$16@18	$16@17	$20.40@22.40	$45.00†	$51.00†
New York (at dock).	14.00	13.00	17.00	.....	.....
Chicago.....	12.00	12.00	12.00	42.00	45.00
St. Louis, salmon (del.)	14.00	14.00	15.00	40.00	42.50
Denver, salmon.....	8@12	8@12	9@10	.....	.....
Dallas.....	*13.50*	13.60	14.10	35.00	.....
San Francisco.....	13.00	13.00	15.00	.....	.....
Los Angeles.....	10.00	10.00	11.00	(not used)	
Boston (del.).....	*17.50*	18.00	19 50	45.00	50.00
Minneapolis (del.).....	13 75	13.75	13.75	.....	.....
Kansas City.....	14 00	14.00	13.50	(no market)	
Seattle.....	14.00	14.00	15.00	.....	55.00
Cincinnati.....	15.50	15.50	15.50	40.00	45.00
Montreal (del.).....	20.25	20.25	20.25	100.00‡	.....
Detroit (del.).....	15.50	15.50	16.00	35.25	38.50
Baltimore.....	18.00	18.00	18.00	40.00	45.00
Atlanta.....	11.50	11.50	12.00	40.00	.....
New Orleans.....	13.00	13.00	15.00	60.00	75.00
Birmingham.....	14.50	14.50	14.50	40.00	45 00
Philadelphia.....	18.00	18.00	18.00	40.00	50.00
Pittsburgh (del.).....	17.00	17.00	16.00	.....	.....
Cleveland.....	14@16	14@16	12@14	.....	.....

* By truck. † In cars. ‡ Imported.

HOLLOW TILE—Price per block in carload lots, f.o.b., to contractors, for hollow building tile.

	New York: Jan. 5 on Trucks*†	One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco†	Perth Amboy N. J., Factory*
4x12x12...	$0.0966	$0.1027	$0.076	$0.105	$0.068	$0.108	.....
6x12x12...	.145	.1541	.104	.....	.09	.156	.....
8x12x12...	.1812	.1926	.142	.21	.126	.244	.....
10x12x12...	.....	....	.182	.....	.158	.....	$0.2432
12x12x12...	.....	....	.202	.32	.186	.....	.3011

*5 per cent off for cash. †Partition tile.

	4x12x12	8x12x12	12x12x12
Boston.....	$0.08	$0.14	$0.235
Minneapolis	.072	.125	.225
Cincinnati.....	.064	.1295	.1726
Kansas City.....	.088	.158	.242
Denver.....	.085	.155	.22
Seattle.....	.10	.18	.26
Los Angeles.....	.085	.172	.285
New Orleans.....	.0808	.1516	.2232
Detroit.....	.068	.1326	.1853
Montreal.....	.10	....	.....
Baltimore.....	.124	.268	.....
Atlanta.....	.068	.125	.....
Dallas.....	.103	.19	.31
Birmingham.....	.11	.124	.255
Pittsburgh.....	.068	.128	.179
Cleveland.....	06	.12	....

STRUCTURAL MATERIAL—Following are base prices per 100 lb. in carload lots, f.o.b. Pittsburgh mill, and Birmingham. At other cities listed, quotations apply on less-than-carload lots from warehouses:

	Pittsburgh	Birmingham	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$1.80	1.90@$2.00	$3.34	$4 00	$3.25	$3.10	$3.15
Channels, 3 to 15 in.....	1.80	1.90@ 2.00	3.34	4.00	3.25	3.10	3.15
Angles, 3 to 6 in., ¼ in. thick	1.80	1.90@ 2.00	3.34	4.00	3.25	3.10	3.15
Tees, 3 in. and larger	1.80	1 90@ 2.00	3.34	4.00	3.35	3.10	3.15
Plates, ¼ in. thick and heavier...	1.80	1 90@ 2.00	3.34	4.00	3.25	3.10	3.15

RIVETS—The following quotations are per 100 lb.:

ROUND-HEAD STRUCTURAL

	Pittsburgh Mill	New York: Jan. 5	New York: One Yr. Ago	Warehouse: Chicago	St. Louis	San Francisco	Dallas
½ in.....	$2.75@$3.00	$5.00	$4.20	$3.60	$3.75	$5.75	$4.75
CONE-HEAD BOILER							
½ in.....	*$3.00*	$5.00	$4.40	$3.60	$3.90	$5.75	$5.00
⅝ and ¾.....	*3.15*	5.15	4.55	3.70	4.10	5.90	5.15
⅞ and 1.....	*3.40*	5.40	4.80	3.95	4.15	6.10	5.50

NAILS—The following quotations are per 100 lb. keg from warehouse:

	Pittsburgh Mill	Birmingham	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire.....	*$2.45@2.55*	$2.85	$2.95	$3.25	$4.25	$2.83	$4.95
Cut.....	2.80	2.90	....	4.90	5.00	*2.88*	5.00

SHIP SPIKES—Current prices per 100 lb.:

In	San Francisco: Galv.	San Francisco: Black	Seattle Black
½..	$7.30	$5.55	$7.75
⅝	6.85	5.10	5.65
¾	6.70	4.95	5.50

Pittsburgh base in lots of 200 kegs or more, *$3.10*.

PREPARED ROOFINGS—Slate-surfaced roofing in rolls weighing 85 to 90 lb. coats $1.93½ per square to contractors in carload lots f.o.b. New York.

Single shingles, slate finish, cost $5.62½ per square (sufficient to cover 100 sq.ft.) in carload lots, f.o.b. New York. Strip shingles (4 in 1) f.o.b. New York, in carload lots to contractors, $4.27½ per square for the hexagonal shape, with Underwriters' label.

ROOFING MATERIALS—Prices f.o.b. New York, to contractors in carload lots:

Tarred felt per 100 lb	$2.94½
Asphalt coating, per gal	.31½
Asphalt felt, per 100 lb	3.09

WINDOW GLASS—United inches, 25, bracket size 6x8 to 10x15, single thickness "AA," 83 per cent; "A," 88 per cent; "B," 89 per cent. Double thickness "AA," 83 per cent; "A," 88 per cent; "B," 89 per cent discount from jobbers list at New York warehouses.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations at mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10.....	$2.10	$3.60	$3.50	$3.75	$3.89
No. 12.....	2.15	3.65	3.55	3.80	3.94
No. 14.....	2.20	3.70	3.60	3.85	3.99
No. 16.....	2.30	3.80	3.70	3.95	4.09
Black					
Nos. 18 to 20.....	*$2.55@2.70*	4.25	3.75	4.60	4.00
No. 22.....	*2.70@2.85*	4.40	3.90	4.75	4.15
No. 24.....	*2.75@2.90*	4.45	3.95	4.80	4.20
No. 26.....	*2.85@3.00*	4.55	4.05	4.90	4.30
No. 28.....	*3.00@3.15*	4.70	4.20	5.05	4.45
Galvanized					
No. 10.....	*$2.90@3.05*	4.55	4.10	4.65	4.25
Nos. 12 to 14.....	*3.00@3.15*	4.65	4.20	4.75	4.35
No. 16.....	*3.10@3.25*	4.75	4.30	4.85	4.45
No. 18.....	*3.25@3.40*	4 90	4.45	5.00	4.60
No. 20.....	*3.40@3.55*	5.05	4.60	5.15	4.75
No. 22.....	*3.45@3.60*	5 10	4.65	5.20	4.80
No. 24.....	*3.60@3.75*	5 25	4.80	5.35	4.95
No. 26.....	*3.85@4.00*	5 50	5.05	5.60	5.20
No. 28.....	*4.10@4.25*	5 75	5.30	5.85	5.45

For galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per 7½-lb. gallon for raw oil:

	New York: Jan. 5	New York: One Year Ago	Chicago: Jan. 5	Chicago: One Year Ago
Raw in barrels (5 bbl. lots)....	$0.79½	$0.81	$0.83	$0.84

E. N.-R. Prices of Construction Materials

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Jan. 5	1 Yr. Ago	Jan. 5	1 Yr. Ago
Red	$13.75	$15.25	$15.25	$16.75
White	13.75	15.25	13.75	15.25

Lumber

Prices wholesale, per M. ft. b.m., in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to contractors at yards.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$29.00	$30.00	$31.00	$34.00
3x6 and 8	29.00	30.00	31.00	34.00
4x4-6 and 8	29.00	30.00	31.00	34.00
3x10 and 12	29.00	30.00	31.00	34.00
3x14	33.00	33.00	34.00	37.00
4x10 and 12	29.00	30.00	31.00	34.00
4x14	33.00	33.00	36.00	37.00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
6x10	$31.00	$33.00	$35.00
6x14	37.00	39.00	41.00
8x10	31.00	33.00	35.00
8x14	37.00	39.00	41.00

New York and Chicago—Wholesale prices to dealers:

	New York		Chicago	
	20 Ft. and Under L.L.Y.P.	22-24 Ft. L.L.Y.P.	20 Ft. and Under No.1 L.L.Y.P.	Up to 32 Ft. No.1 Douglas Fir
3x4 to 8x8	$41.00@43.00	$42.00@44.00	$37.00	$39.50
3x10 to 10x10	48.00@50.00	49.00@51.00	45.00	39.50
3x12 to 12x12	55.00@57.00	56.00@58.00	55.00	39.50
3x14 to 14x14	63.00@65.00	64.00@66.00	.....	39.50
3x16 to 16x16	75.00@77.00	76.00@78.00	.....	40.50

New York—Prices are for long-leaf yellow pine timbers (rough) to dealers, alongside dock. Price to contractors, delivered by trucks from lighters to job, $5@$10 additional. Short leaf pine costs $3 per M. ft. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 32 ft. and $1 for each additional foot from 32 to 36 ft.

Other Cities—On cars or at dock:

	8x8-In. x 20 Ft. and Under				3x12 to 12x12-In. 20 Ft. and Under	
	P.	Fir*	Hemlock	Spruce	P.	Fir*
Boston	$48.00	$47.50	$49.00	$52.00	$57.50	$57.00
Seattle	.....	24.00	.....	.....	.....	24.00
New Orleans	45.00	.....	.....	.....	46.50	.....
Baltimore	35.00	49.25	53.00	60.00	.....	49.75
Cincinnati	33.00	46.00	44.00	44.00	37.00	50.00
Montreal	50.00	55.00	.....	.....	60.00	50@55
Los Angeles	.....	32.00	.....	32.00	.....	32.00
Denver	.....	32.75	32.75	32.75	33.75	33.75
Minneapolis	42.50	37.75	38.50	.....	47.00	38.75
Atlanta	31.00	.....	.....	.....	34.00	.....
Dallas	56.00	.....	.....	.....	56.00	.....
Kansas City, Mo.	40.50	39.25	.....	.....	54.50	39.75
Birmingham	32.00	.....	.....	.....	34.00	.....
Philadelphia	48.00	35.00	40.00	45.00	60.00	35.00
Detroit	42.00	40.50	.....	.....	56.00	40.50
St. Louis	40.00	.....	.....	.....	51.50	.....

	1-In. Rough, 10 In. x 16 Ft. and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir*	Hemlock	P.	Fir*
Boston	$43.50	$43.00	$44.50	$48.50	$48.00
Seattle	.....	22.00	.....	.....	23.50
New Orleans	30.00	.....	.....	40.00	.....
Baltimore	55.00	44.00	44.00	34.00	49.50
Cincinnati	27.00	32.00	30.00	28.50	45.00
Montreal	45.00	55.00	40.00	65.00	50.00
Los Angeles	.....	24.50	.....	.....	36.00
Denver	.....	32.75	33.25	.....	31.75
Minneapolis	40.50	36.25	34.75	35.50	35.00
Atlanta	22.00	.....	.....	28.00	.....
Dallas	52.25	.....	.....	56.00	.....
Kansas City, Mo.	51.75	42.75	.....	39.75	39.75
Birmingham	27.00	.....	.....	45.00	.....
Philadelphia	32.00	35.00	37.00	50.00	35.00
Detroit	40.50	37.00		30.50	41.25
St. Louis	39.00	.....	.....	27.50	.....

*Douglas fir.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in. —2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

Miscellaneous

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Jan. 5	One Month Ago	One Year Ago
$2.20@$2.25	$2.20@$2.25	$2.25@$2.30

CONCRETE BLOCKS—Standard 8x8x16-in., delivered to job, each:

Denver	$0.22	St. Louis	$0.20
Detroit	.16	Boston	.18@.20
New Orleans	....	Minneapolis	.14*
Brooklyn and Queens	.18	Philadelphia	.18@.20
Pittsburgh	.18	*F.o.b.	

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope (*add to list*)	12½%

California, Oregon, Nevada and Washington: Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¼-in., 8 ft.; ⅜-in., 6; ½-in., 4½; ⅝-in., 3½; ¾-in., 2 ft. 10 in.; 1-in., 2 ft. 4 in. Following are prices per pound for ¼-in. and larger, in 1200-ft. coils:

Boston	$0.25	New Orleans	$.23½
New York	.26	Los Angeles	.25
Chicago	.23½	Seattle	.23
Minneapolis	.25½	St. Louis	.23
San Francisco	23	Montreal	.17
Atlanta	22	Detroit	.24½
Denver	.25½@.26½	Baltimore	.26
Cincinnati	.21	Kansas City	.25½
Dallas	.31	Birmingham	.26@.27
Philadelphia	.25		

EXPLOSIVES—Price per pound for dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.265*	$0.2875*
Boston	.24	.27
Kansas City	.205	.225
Seattle	.165	.19
Chicago	.195†	.2175†
Minneapolis	.1917	.2123
St. Louis	.22	.24½
Denver	.2025	.2275
Dallas	.225	.306
Los Angeles	.1875	.2225
Atlanta	.245	.255
Baltimore	.22	.23
Cincinnati	.22	.245
Montreal	.195	.22
Birmingham	.22	.24
New Orleans	.235	.26
San Francisco	.1625	.1925
Philadelphia	.215	.24

*Special gelatin in case lots. †Quantities above 500. lb., and less than a ton.

CHEMICALS—Water and sewage treatment chemicals, round lots at New York:

Sulphate of aluminum, in bags, per 100 lb	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb	5.00@ 5.10
Soda ash, 58%, in bags, per 100 lb	1.32@ 1.35
Chlorine, liquid, cylinders, per lb	.05½@ .08
Hypochlorite of lime (bleaching powder) in drums, per 100 lb	2.00@2.10*

*F. o. b. works.

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb. or 18 tons:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.735
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.29	St. Louis	.43
Cleveland	.19	St. Paul	.60
Denver	1.15*		

* Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.

A Consolidation of Engineering News, Engineering Record and The Contractor

ENGINEERING NEWS-RECORD

McGraw-Hill Publishing Co., Inc.
JAMES H. McGRAW, *President*
E. J. MEHREN, *Vice-President*

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

WILLARD CHEVALIER
General Manager
F. E. SCHMITT
Managing Editor

Volume 100 NEW YORK, JANUARY 12, 1928 Number 2

The Engineering Year In Review and Prospect

An Editorial Survey

IN THIS ISSUE there is presented a review of the year just closed, as seen from the vantage point of engineering thought. It comprises an editorial survey of developments in the different fields of professional activity, notes and views of large projects, and a summary of the essential statistics of construction. These have been prepared by the editors to assist the reader in his own retrospect and forecast. In order that the inspiration of professional thought might not be lacking, there are included four articles by prominent engineers presenting studies of broad questions that have special importance in relation to the day's work. One of the major movements of the day, the intense activity in constructing large bridges for the service of transportation on the modern highway, is discussed by the dean of American bridge builders, Gustav Lindenthal. Prof. Raymond Olney outlines what the engineer has done to smooth man's path in the world's basic production activity, agriculture; he points out how scientific application of machine power is furthering the work of transforming the farmer from peasant to industrialist. A related process of mechanization is discussed by Charles H. Paul of the Arrowrock dam and the Miami conservancy enterprise, who deals with the operations of earth-moving. And, finally, since it is impossible to overlook the effect of the great Mississippi flood of last spring, W. W. DeBerard outlines its critical aspects, from the perspective derived from personal familiarity with the river and the advantages of a broad knowledge of engineering and public relations.

A Prosperous Year

WHATEVER the engineer's direct activity, he is affected vitally by the state of the business and political world. Looking out upon this broad landscape, he perceives favorable conditions. As to business, the civilized world is prosperous, the United States pre-eminently so; and politically that same world has been fairly well at rest, again the United States pre-eminently so. Probably both conditions may be traced back to the imperative need for production. After years spent in crude patching of economic and political structures, a relative confidence in the stability of political institutions supervened; hence, financial steadiness, witnessed at home by tremendous credit expansion and low discount rates, and abroad by currency reform or stabilization in a number of countries that still had haphazard money values. These matters favored large-scale expansion of production and consumption.

Remarkably enough, in Europe this improvement of favoring conditions, which to lesser degree existed during the two years preceding, made progress in spite of economic unbalance created by the non-selfcontained character of many of the countries and their continued isolation by customs obstacles or by absolute trade prohibitions. Evidently the pressure of demand and the necessities of trade at the moment were prevailing. An effort was made at an international economic congress last summer to remove the worst of such barriers, but, so far, with only paper results, except for the signing of a convention by a number of powers doing away with absolute prohibition of exports and imports.

Within the United States, in the absence of trade barriers the upbuilding forces of this late stage of the reconstruction epoch were able to work unhindered. They produced a year which the highest authorities have uniformly characterized as prosperous without precedent in all history, even against slightly greater business activity in some lines during 1926. And this prosperity as a whole was sound—a healthy development of industry and construction backed by a well regulated financial system and with such fairness in the distribution of production that labor troubles were almost non-existent. How great a surplus of productive energy the country possesses revealed itself in the fact that the destruction of several hundred million dollars of value by flood made not even a momentary impression on business or on market values.

Some Dark Spots

THERE have been some dark spots in the world prospect. Abroad these are chiefly political. In addition to the continued civil war in China and the isolation of Russia, several international rivalries loomed up sharply in Europe. Pre-war international diplomacy, far from being discredited, re-established itself further. The competitive attitude of governments came glaringly into view through the utter failure of attempts to discuss reduction of armament. Now that the United States is a creditor nation and has extensive business investment in Europe, the gloomy forebodings of those who see another war in the making are not wholly without meaning to us. On the business side, the reconstruction of England was slower than expected, the huge international debts owed to the United States are still in part unregulated, the reparations obligations are not fixed, and the relations between Germany and France are incompletely adjusted. But the business world developed an important counter-movement to political reaction, through the completion of several pan-European trade combines, designed to minimize international competition. However undesired this development may be from the American business view, it represents a potential agency of national stability.

E. N.-R. Prices of Construction Materials

WHITE AND RED LEAD—Per 100-lb. keg, base price f.o.b. New York:

	Dry		In Oil	
	Jan. 5	1 Yr. Ago	Jan. 5	1 Yr. Ago
Red	$13.75	$15.25	$15.25	$16.75
White	13.75	15.25	13.75	15.25

Lumber

Prices wholesale, per M. ft. b.m., in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to contractors at yards.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$29.00	$30.00	$31.00	$34.00
3x6 and 8	29.00	30.00	31.00	34.00
4x4-6 and 8	29.00	30.00	31.00	34.00
3x10 and 12	29.00	30.00	31.00	34.00
3x14	33.00	33.00	34.00	37.00
4x10 and 12	29.00	30.00	31.00	34.00
4x14	33.00	33.00	35.00	37.00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
6x10	$31.00	$33.00	$35.00
6x14	37.00	39.00	41.00
8x10	31.00	33.00	35.00
8x14	37.00	39.00	41.00

New York and Chicago—Wholesale prices to dealers:

	New York		Chicago	
	20 Ft. and Under L.L.Y.P.	22-24 Ft. L.L.Y.P.	20 Ft. and Under No.1 L.L.Y.P.	Up to 32 Ft. No.1 Douglas Fir
3x4 to 8x8	$41.00@43.00	$42.00@44.00	$37.00	$39.50
3x10 to 10x10	48.00@50.00	49.00@51.00	45.00	39.50
3x12 to 12x12	55.00@57.00	56.00@58.00	55.00	39.50
3x14 to 14x14	63.00@65.00	64.00@66.00	.....	39.50
3x16 to 16x16	75.00@77.00	76.00@78.00	.....	40.50

New York—Prices are for long-leaf yellow pine timbers (rough) to dealers, alongside dock. Price to contractors, delivered by trucks from lighters to job, $5@$10 additional. Short leaf pine costs $3 per M. ft. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 32 ft. and $1 for each additional foot from 32 to 36 ft.

Other Cities—On cars or at dock:

	8x8-In. x 20 Ft. and Under				3x12 to 12x12-In. 20 Ft. and Under	
	P.	Fir*	Hemlock	Spruce	P.	Fir*
Boston	$48.00	$47.50	$49.00	$52.00	$57.50	$57.00
Seattle	.....	24.00	.....	.....	.....	24.00
New Orleans	45.00	.....	.....	.....	46.50	.....
Baltimore	35.00	49.25	53.00	60.00	.....	49.75
Cincinnati	33.00	46.00	44.00	44.00	37.00	50.00
Montreal	50.00	55.00	.....	.....	60.00	50@55
Los Angeles	.....	32.00	.....	32.00	.....	32.00
Denver	.....	32.75	32.75	32.75	33.75	33.75
Minneapolis	42.50	37.75	38.50	.....	47.00	38.75
Atlanta	31.00	.....	.....	.....	34.00	.....
Dallas	56.00	.....	.....	.....	56.00	.....
Kansas City, Mo.	40.50	39.25	.....	.....	54.50	39.75
Birmingham	32.00	.....	.....	.....	34.00	.....
Philadelphia	48.00	35.00	40.00	45.00	60.00	35.00
Detroit	42.00	40.50	.....	.....	56.00	40.50
St. Louis	40.00	.....	.....	.....	51.50	.....

	1-In. Rough, 10 In. x 16 Ft. and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir*	Hemlock	P.	Fir*
Boston	$43.50	$43.00	$44.50	$48.50	$48.00
Seattle	.....	22.00	.....	.....	23.50
New Orleans	30.00	.....	.....	40.00	.....
Baltimore	55.00	44.00	44.00	34.00	49.50
Cincinnati	27.00	32.00	30.00	28.50	45.00
Montreal	45.00	55.00	40.00	65.00	50.00
Los Angeles	.....	24.50	.....	.....	36.00
Denver	.....	32.75	33.25	.....	31.75
Minneapolis	40.50	36.25	34.75	35.50	35.00
Atlanta	22.00	.....	.....	28.00	.....
Dallas	52.25	.....	.....	56.00	.....
Kansas City, Mo.	51.75	42.75	.....	39.75	39.75
Birmingham	27.00	.....	.....	45.00	.....
Philadelphia	32.00	35.00	37.00	50.00	35.00
Detroit	40.50	37.00	.....	30.50	41.25
St. Louis	39.00	.....	.....	27.50	.....

*Douglas fir.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in. —2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

Miscellaneous

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Jan. 5	One Month Ago	One Year Ago
$2.20@$2.25	$2.20@$2.25	$2.25@$2.30

CONCRETE BLOCKS—Standard 8x8x16-in., delivered to job, each:

Denver	$0.22	St. Louis	$0.20
Detroit	.16	Boston	.18@.20
New Orleans	....	Minneapolis	.14*
Brooklyn and Queens	.18	Philadelphia	.18@.20
Pittsburgh	.18	*F.o.b.	

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope (*add to list*)	12½%

California, Oregon, Nevada and Washington: Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¾-in., 8 ft.; ½-in., 6; ⅜-in., 4½; 1-in., 3½; 1¼-in., 2 ft. 10 in.; 1½-in., 2 ft. 4 in. Following are prices per pound for ¾-in. and larger, in 1200-ft. coils:

Boston	$0.25	New Orleans	$.23½
New York	.26	Los Angeles	.25
Chicago	.23½	Seattle	.23
Minneapolis	.25½	St. Louis	.23
San Francisco	.23	Montreal	.17
Atlanta	.22	Detroit	.24½
Denver	.25½@.26½	Baltimore	.26
Cincinnati	.21	Kansas City	.25½
Dallas	.31	Birmingham	.26@.27
Philadelphia	.25		

EXPLOSIVES—Price per pound for dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.265*	$0.2875*
Boston	.24	.27
Kansas City	.205	.225
Seattle	.165	.19
Chicago	.195†	.2175†
Minneapolis	.1917	.2123
St. Louis	.22	.24½
Denver	.2025	.2275
Dallas	.225	.306
Los Angeles	.1875	.2225
Atlanta	.245	.255
Baltimore	.22	.23
Cincinnati	.22	.245
Montreal	.195	.22
Birmingham	.22	.24
New Orleans	.235	.26
San Francisco	.1625	.1925
Philadelphia	.215	.24

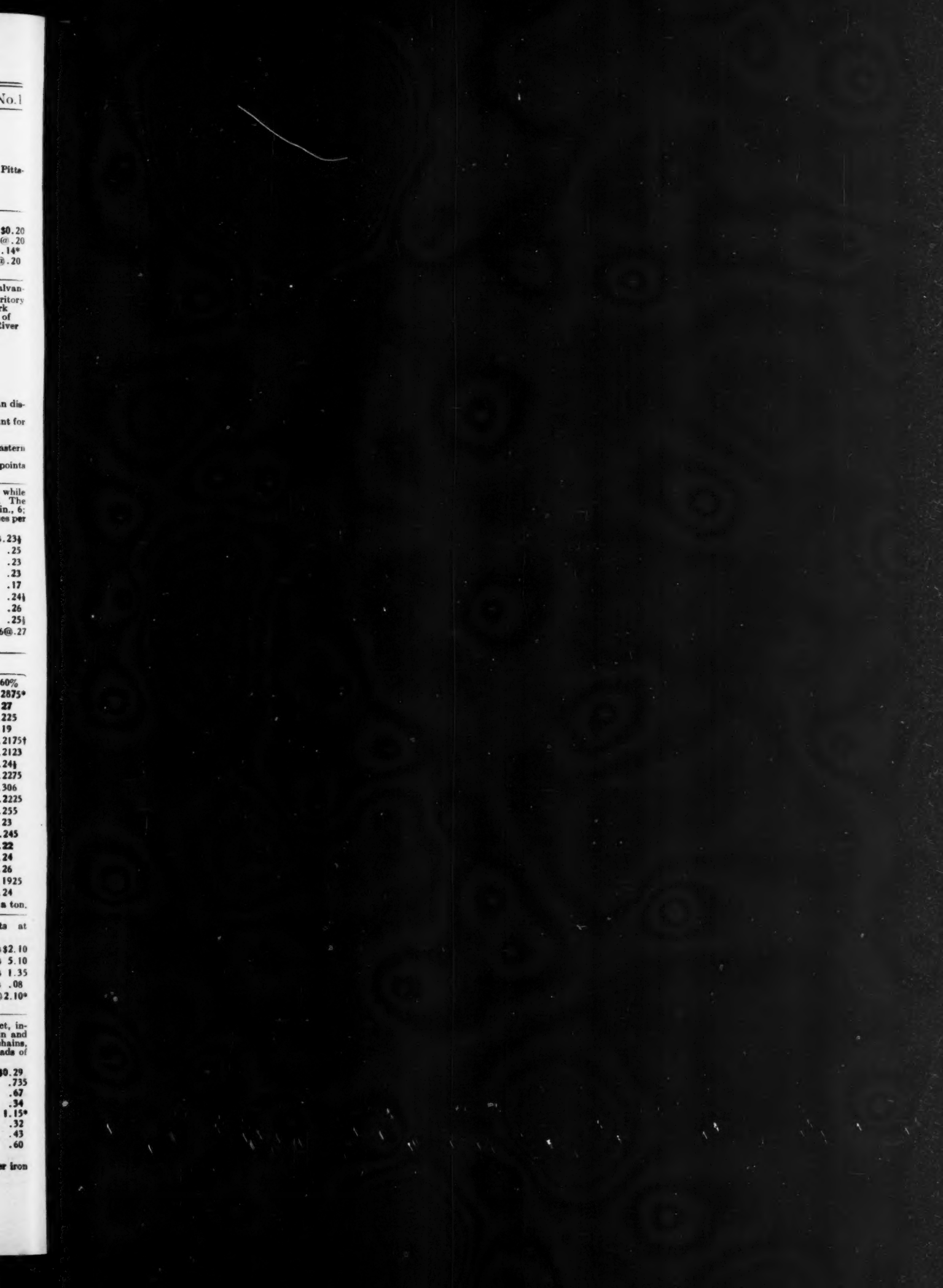
*Special gelatin in case lots. †Quantities above 500. lb., and less than a ton.

CHEMICALS—Water and sewage treatment chemicals, round lots at New York:

Sulphate of aluminum, in bags, per 100 lb	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb	5.00@ 5.10
Soda ash, 58%, in bags, per 100 lb	1.32@ 1.35
Chlorine, liquid, cylinders, per lb	.05½@ .08
Hypochlorite of lime (bleaching powder) in drums, per 100 lb	2.00@2.10*

*F. o. b. works.

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb. or 18 tons:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.735
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.29	St. Louis	.43
Cleveland	.19	St. Paul	.60
Denver	1.15*		

* Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.